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THE POTATO IN CANADA

By

T. F. RITCHIE

DIVISION OF HORTICULTURE
EXPERIMENTAL FARMS SERVICE

with

A Section on Insects Affecting the Potato

By

Alan G. Dustan, Division of Entomology
Science Service

And

A Section on Potato Diseases

Contributed by
The Division of Botany and Plant Pathology
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THE POTATO IN CANADA

By T. F. Ritchie

HISTORY AND BOTANY

The potato is a native of South America, found principally in Chili and Peru. It was probably cultivated and used as a food plant by the Incas prior to the discovery of America. In the latter part of the sixteenth century the first tubers are thought to have been taken from Peru to Spain by Spanish explorers. About 1586 Sir Walter Raleigh or some of his colonists took tubers from Virginia to Ireland. The first planting was done on the estate of Sir Walter Raleigh at Youghal, near Cork, and from there potatoes spread through Ireland and later to England. During 1663 the efforts of the Royal Horticultural Society to introduce the potato as a source of cheap food met with little success. It was not until the famine in Scotland in 1743 that the value of the potato as a cheap food was impressed upon the people. Further records show that in 1771 a prize was offered in France for a food that would take the place of wheat in case of emergency, and it was at this time that the potato came into great prominence in France. The growing of potatoes in the United Kingdom and continental Europe increased rapidly from then on. The famine in Ireland in 1846, caused by blight rot, gives evidence of the total dependence of the masses of Western Europe upon the potato as food.

The potato *(Solanum tuberosum)* is a herbaceous perennial that belongs to the Solanaceae or nightshade family, in which there are over 800 species. Of these several hundred species, only four produce tubers of sufficient size to be considered of commercial value. In order of importance they are as follows: *S. tuberosum,* which is the common potato so widely known in commerce and includes all the white varieties; *S. commessonii,* a coloured form used in a limited way by the inhabitants of Western Europe; *S. jamesii,* the wild potato of Arizona; and *S. maglia,* found growing wild in the Rocky Mountain regions. There are many near relatives of the potato, such as tomato, tobacco, pepper, eggplant, henbane, petunia, black nightshade, belladonna, bittersweet and jimson weed, all of which contain the chemical, solanin.

Under normal conditions, the potato plant will develop to a height of 2 to 3 feet, depending on the variety and environmental conditions. The stems are angular and solid in cross-section, some varieties showing more of the winged character. The leaves are compound, with the leaflets opposite varying from crinkled to broad flat. The largest leaflets are at the apex and they diminish in size toward the base of the leaf. The blossoms are borne in clusters terminally, each consisting of a rotate five-pointed corolla beneath which a similar shaped calyx is found. The corolla colour varies with the variety, from white to mauve, purple or deep violet. The potato seed-balls, or true fruits, resemble small tomatoes, but are more spherical and vary from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter. The seeds are imbedded in the pulp and attached to the placenta. Seed-ball production is not profuse on the present standard varieties, particularly in the warm dry sections. This is due, possibly, to a scarcity of viable pollen, to dropping of the buds prematurely, and possibly to degeneration of the flowering parts of the varieties now being grown. There

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does not seem to be any connection between the flowering or seed-ball production and the development of tubers. In reality the tuber is a thickened or shortened part of the underground stem. The tuber is usually produced at the end of the stem or stolon, but occasionally lateral sessile tubers are produced. Tuber formation usually occurs at the end of the period of flower-bud development, when nearly all the tubers that are to develop are set. It is important that favourable soil and seasonal conditions prevail at this very critical time.

IMPORTANCE

The potato is one of the most widely known and used vegetables, as a food for man and a source of cheap starch and alcohol. From the time when it was first adopted as a food plant in the seventeenth century until the present, the acreages devoted to potato growing have increased enormously. Fluctuations in production occur from year to year but in the main production is fairly constant. It has become a staple food the world over where the white races of people are found.

Improvement in the size, shape and quality of the potato of to-day over those of the potatoes first known has been brought about by the origination of new varieties and by careful selection and better cultural methods.

WORLD POTATO PRODUCTION

To give a clear idea of the area devoted to potatoes and of the production of potatoes in 31 countries, including Canada, table 1 is presented from the Monthly Crop Report and Agricultural Statistics, Reprint from the International Review of Agriculture (year XXX November, 1939, No. 11).

TABLE 1—AREA AND PRODUCTION OF POTATOES IN 31 COUNTRIES

Countries	Area					Production							
	1939 and 1939–40	1938 and 1938–39	Average 1933 to 1937 and 1933–34 to 1937–38	% 1938 and 1938–1939 =100	1939 and 1939–40 Average =100	1939 and 1939–40	1938 and 1938–39	Average 1933 to 1937 and 1933–34 to 1937–38	1939 and 1939–40	1939 and 1938–39	Average 1933 to 1937 and 1933–34 to 1937–38	% 1938 and 1938–1939 =100	1939 and 1939–40 Average =100
	000 acres					000 centals			000 bushels of 60 lb.				
Albania	.....	.....	0	.....	.....	.....	.....	34	.....	.....	57	.....	.....
Germany (1) (s)	388	428	(2)	90·7		38,361	44,754	(2)	66,933	74,558	(2)	85·7	
(t)	7,460	7,618	7,777	97·9	100·9	1,202,405	1,198,878	1,118,409	2,003,969	1,998,090	1,863,977	100·3	110·9
Belgium	363	364	398	99·7	91·4	.....	71,836	71,759	.....	119,725	119,596	.....	.....
Bohemia-Moravia (Protectorate) (s)	40	39	—	102·5	—	.....	.....	—	.....	.....	—	.....	—
(t)	828	821	—	100·8	—	.....	.....	—	.....	.....	—	.....	—
Bulgaria	49	49	40	99·0	122·4	.....	1,401	2,384	.....	2,334	3,974	.....	.....
Denmark	168	196	190	85·9	88·5	.....	31,586	28,792	.....	52,642	47,988	.....	.....
Spain	1,006	.....	(3) 1,127	—	89·3	.....	.....	(3) 110,723	.....	.....	(3) 184,534	.....	.....
Estonia	221	193	180	114·7	123·2	19,061	21,994	20,944	31,768	36,656	34,906	86·7	91·0
Finland	219	211	208	103·9	105·6	34,304	26,409	28,707	57,172	44,014	47,844	129·9	119·5
France	3,415	3,521	3,496	97·0	97·7	.....	381,721	339,176	.....	636,189	565,281	.....	.....
Greece	.....	53	49	.....	.....	.....	3,153	2,857	.....	5,254	4,761	.....	.....
Hungary	(4) 778	(5) 720	(5) 720	—	—	(4) 52,131	(5) 47,193	(5) 45,758	(4) 86,883	(5) 78,653	(5) 76,261	—	—
Ireland	.....	327	336	.....	.....	.....	55,123	57,103	.....	91,872	95,172	.....	.....
Italy (s)	83	84	(6) 73	98·6	113·1	7,240	8,015	(6) 5,826	12,066	13,358	(6) 9,710	90·3	124·3
(t)	959	956	971	100·3	98·8	.....	57,000	54,251	.....	94,998	90,417	.....	.....
Latvia	359	340	288	105·5	124·7	36,525	38,611	33,964	60,873	64,350	56,606	94·6	107·5
Lithuania	437	460	444	95·1	98·4	46,377	46,699	47,013	77,294	77,830	78,354	99·3	98·6
Luxemburg	43	43	41	99·8	103·5	5·776	6,296	3,982	9,626	10,492	6,636	91·7	145·0
Malta	9	9	8	98·4	102·8	693	629	560	1,156	1,049	933	110·2	123·9
Norway	.....	132	124	.....	.....	20,743	20,671	19,842	34,571	34,452	33,070	100·3	104·5
Netherlands:													
p. for consumption	237	224	287	105·6	82·4	56,218	43,509	46,674	93,695	72,513	77,788	90·4	92·3
p. for starch	71	76	61	93·5	116·1		18,672	14,219		31,119	23,697		
Poland	7,562	7,487	7,039	101·0	107·4	.....	761,881	744,303	.....	1,269,777	1,240,480	.....	.....
Portugal	.....	77	80	.....	.....	.....	13,068	12,353	.....	21,779	20,587	.....	.....
Roumania:													
single crop	.....	476	515	.....	.....	.....	36,695	39,902	.....	61,157	66,503	.....	.....
p. with maize	.....	226	226	.....	.....	.....	3,027	3,373	.....	5,046	5,621	.....	.....
United Kingdom:													
England and Wales	454	475	476	95·6	95·3	.....	78,086	70,497	.....	130,144	117,495	.....	.....
Scotland	134	135	139	99·4	96·7	.....	20,563	21,952	.....	34,272	36,587	.....	.....
Northern Ireland	115	123	133	93·2	86·8	.....	15,935	19,761	.....	26,558	32,934	.....	.....

TABLE 1—AREA AND PRODUCTION OF POTATOES IN 31 COUNTRIES—*Concluded*

Countries	Area					Production							
	1939 and 1939-40	1938 and 1938-39	Average 1933 to 1937 and 1933-34 to 1937-38	% 1938 and 1938-1939 =100	1939 and 1939-40 Average =100	1939 and 1939-40	1938 and 1938-39	Average 1933 to 1937 and 1933-34 to 1937-38	1939 and 1939-40	1939 and 1938-39	Average 1933 to 1937 and 1933-34 to 1937-38	% 1938 and 1938-1939 =100	1939 and 1939-40 Average =100
	000 acres					000 centals			000 bushels of 60 lb.				
Sweden	339	338	327	100·1	103·7	42,882	41,283	41,708	71,469	68,803	69,513	103·9	102·8
Switzerland	125	123	116	101·2	107·2	14,683	17,882	16,760	24,471	29,802	27,933	82·1	87·6
Yugoslavia (*s*)	.....	658	635	.....	.....	.....	37,515	34,534	.....	62,524	57,556	.....	.....
Yugoslavia (*t*)								(2)			(2)		
U.S.S.R.	.....	.....	16,875	.....	.....	.....	.....	1,249,312	.....	.....	2,082,146	.....	.....
Canada	522	522	527	100·0	99·0	.....	35,938	42,334	.....	59,897	70,557	.....	.....
United States	3,074	3,020	3,357	101·8	91·6	217,059	222,970	223,302	361,765	371,617	372,170	97·3	97·2
Mexico	.....	40	32	.....	.....	.....	1,575	1,387	.....	2,624	2,311	.....	.....
Cyprus	.....	6	6	.....	.....	504	504	479	840	840	799	100·0	105·2
Palestine	.....	2	2	.....	.....	.....	193	89	.....	322	148	.....	.....
Syria and Lebannon	.....	19	18	.....	.....	.....	918	885	.....	1,530	1,475	.....	.....
Turkey	.....	134	127	.....	.....	.....	3,717	3,514	.....	6,194	5,857	.....	.....
Algeria (*s*)	22	17	17	125·7	131·1	1,370	1,470	995	2,284	2,450	1,658	93·2	137·7
Algeria (*t*)	26	26	23	100·5	111·6	.....	1,734	1,389	.....	2,890	2,315	.....	.....
Egypt	.....	10	8	.....	.....	.....	942	814	.....	1,570	1,356	.....	.....
Tunisia	7	7	5	100·0	147·1	.....	121	152	.....	202	254	.....	.....
Argentina	.....	309	296	.....	.....	.....	15,704	14,728	.....	26,172	24,546	.....	.....
Chile	.....	134	126	.....	.....	.....	9,644	10,142	.....	16,073	16,903	.....	.....
New Zealand	.....	18	23	.....	.....	.....	.....	2,842	.....	.....	4,736	.....	.....

(s) Early potatoes. *(t)* Late potatoes. (1) Including Ostmark and Sudetenland. (2) Average 1932 to 1937. (3) Average 1933-1935. (4) Including the northern region annexed to Hungary, but not including Sub-Carpathian Russia. (5) Territory at the end of 1937. (6) Average 1935 to 1937.

IMPORTANCE IN CANADA

In Canada the potato is used almost as freely as bread by all classes of people. It is adapted to growing in almost every section of the country from the extreme eastern provinces, where very large yields per acre are obtained, through the central provinces to the extreme western coast. Northwards the potato has progressed towards the Arctic circle, giving remarkable returns under cool climatic and soil conditions, wherever the season is frost-free long enough for the plants to make their growth.

During the last half century there has been a decided change in the status of the potato industry. Improved varieties have been used in preference to the misshapen, rough, elongated and dark-coloured varieties then known. At the present time the pink-skinned varieties are used considerably although the white-skinned varieties are used to a much greater extent. In certain sections those varieties with heavily netted skins are popular, but the growing demand is for the white-skinned varieties.

Reference to statistics obtained from the Monthly Bulletin of Agricultural Statistics, January, 1939, gives some interesting figures that show the trend in potato production. In 1939 the acreages were smaller and the yields reduced by 9 hundredweight per acre from the average for the years 1932 to 1936, but with better prices the gross farm value of the crop exceeded the average and was better than that of the two previous years, as shown in table 2.

TABLE 2—ACREAGE, PRODUCTION AND VALUE OF POTATOES IN CANADA

Year	Area	Yield per acre	Total production	Average farm price	Gross farm value
	acres	cwt.	cwt.	per cwt.	$
Average 1932-36	525,400	79·0	41,708,000	0·76	31,563,000
1937	531,200	80·0	42,547,000	0·63	26,650,000
1938	521,900	69·0	35,938,000	0·75	27,079,000
1939	517,700	70·0	36,390,000	1·07	39,040,000

According to information supplied by the Department of Trade and Commerce on December 11, 1939, the outlook for the sale of Canadian seed potatoes in the United States is good, and there should be little difficulty in disposing of any moderate surplus of table stock.

Prior to 1930 the duty on potatoes, both seed and table stock, was 50 cents per 100 pounds. In that year it was raised to 75 cents until 1936 when the first Trade agreement between Canada and the United States reduced the duty on certified seed to 60 cents between December 1 and the end of February and to 45 cents for the balance of the year on quantities up to 750,000 bushels of seed for the twelve months beginning December 1 of each year. This quota was doubled to 1,500,000 bushels by the 1938 agreement, and the duty reduced to 37½ cents for the period March to November. At the same time these new duties were applied to table stock imports up to a total of 1,000,000 bushels plus the difference between the domestic crop and 350,000,000 bushels, whenever the United States production falls below that figure. The new agreement changed the starting date of the quota from December 1 to September 15, which corresponds more closely with each shipping season.

A fairly brisk export trade is carried on with the shipment of certified seed potatoes to the following countries: United States, Bermuda, British Guiana, Jamaica, Trinidad and Tobago, Newfoundland, Argentina, Cuba, Panama, San Domingo, Uruguay, and Venezuela. This represented the shipment of 1,573,485 bushels with a value of 1,405,320 dollars in 1939 as against 2,186,098 bushels with

a value of 2,166,274 dollars in 1938. These figures cover the months of January, February and March for the respective years. There has been a decline in this trade as will be noted from the statements for the two-year period. The largest exports have been made to the United States, Cuba and Argentina.

With high prices for stock and poultry feeds and very low prices for potatoes, the stock raisers located near plentiful supplies of potatoes have a good opportunity to reduce their feed bills by feeding potatoes. When the true value of potatoes as stock and poultry feed is fully realized, much larger quantities than at present will be fed. Stock raisers would be well advised to inform themselves fully on the proper methods of feeding potatoes in the rations to secure the best results. In brief, it may be pointed out that potatoes are, in fact, "watered" carbohydrate concentrates. They may be used, therefore, as a substitute for barley and corn, as in the rations of pigs, in which case it is important to bear in mind that four pounds of potatoes are equal to one pound of cereal meal.

CLIMATIC AND SOIL REQUIREMENTS

The influence exerted by climatic conditions on the potato crop is considerable. It is known that the potato does best where the growing season temperatures range from 60° to 75° F. Northern New Brunswick, Prince Edward Island and other sections of Canada where cool growing conditions prevail are ideal for maximum yield.

While the soil is important, it is of less importance than the effect exerted by the proper climatic conditions. Soil influence is measured in yield, earliness of maturity, eating quality, keeping quality, and loss by disease. The ideal soil is a rich, deep, friable, medium loam inclined to be slightly acid or with a pH reading of from 5·2 to 6·5. The light or sandy soils are as a rule low in humus and lack sufficient moisture to meet the normal requirements of the potato. The heavy soils should be avoided since there is greater danger of rot developing in the tubers during wet years. Under dry conditions, the heavy soils render digging very difficult and produce potatoes of inferior quality and lacking in smoothness and uniformity. The best soils are those that are of glacial drift origin such as are found in northern New Brunswick.

SOIL MANAGEMENT AND SANITATION

It is important that the land used for potato production be kept in a satisfactory state of fertility. This can be best accomplished by following a rotation wherein the potato crop occurs in a regular cycle. One of the best means of maintaining ideal conditions is by following a three-year rotation, as follows: First year, grain seeded with clover; second year, clover hay and, third year, potatoes. Following the removal of the hay in the second year top dress the land, preferably with rotted manure, applying 10 to 12 tons per acre. Fresh stable manure may be used but is not recommended on account of its content of weed seeds. The second-growth clover should be allowed to grow, so that by the autumn a heavy crop will be ready for ploughing down.

Filling a double role, clover has been found to be one of the most useful of the soil improvement crops to employ. In the first place it is a true legume that gathers nitrogen during the period of growth, and this nitrogen is added to the land in which the crop grows. In the second place, the second-growth clover, when ploughed down, adds humus to the land, acting as a splendid soil improver.

In addition to the above commendable features of clover in a short rotation for potatoes, it also discourages the development of insects, such as wireworms and white grubs, which feed on grass roots.

The practice of rotating crops also aids in lessening the annual losses sustained from diseases that frequently become troublesome where potatoes are grown two or more years in succession in the same land.

Thorough preparation of the soil will ensure a perfect seed-bed and will have a very definite effect upon the moisture, aeration, temperature and available plant food of the soil. In turn, the shape, quality and yield of tubers will also be influenced by these factors. The easily worked soils suited to potato growing offer few physical difficulties, and under proper management will produce profitable crops. More difficulty is found where soils are heavy and require treatment to produce friable conditions. The use of green manure crops, such as rye, barley, or buckwheat ploughed down tends to improve the texture of such soils. Rye is a rapid-growing hardy crop that will do well on acid and poor soils, producing a heavy tonnage of succulent green growth. Barley also is a very rapid-growing crop that produces a heavy succulent growth. Buckwheat produces a rapid heavy growth, coupled with a strong tap-root system that penetrates the substrata and tends to produce greater openness in the subsoil, in addition to improving the general texture of the top soil. Fall ploughing is usually employed where the soil is heavy or where coarse litter or corn stubble is to be turned under. As a general rule spring ploughing is employed since the greatest acreage of potatoes is grown on the lighter soils that are easy to handle. The shallow, light soils, that have hardpan substrata can be improved by gradually ploughing a little deeper, thus incorporating a little of the hardpan at each subsequent ploughing with the upper layer of good soil.

Preparation of the ploughed land prior to planting can hardly be overdone. Preplanting tillage will do more to ensure a good crop than a great deal of interrow tillage during the season of growth.

MANURES AND FERTILIZERS

The potato crop, being a heavy feeder and capable of giving large returns both in yield and income per acre, can use a liberal amount of manure and commercial fertilizer. Plenty of available plant food is necessary for the production of a profitable crop.

Barnyard manure that has been properly piled and decomposed is recognized as a very desirable form of organic fertilizer to use. A good method to follow is to apply manure as a top dressing to the sod land previous to ploughing. In fact it is desirable to apply manure to the meadow land the year previous to ploughing the sod. In this way it stimulates the hay crop and becomes thoroughly broken down and incorporated with the soil, making the plant food more available to the succeeding potato crop and lessening the danger of encouraging potato scab. Fresh farmyard manure or horse manure, being high in ammonia, has been found to promote the activity of the scab organism, and should therefore not be applied to potato land just previous to planting time. Excessive applications of manure will be found to promote very rank top growth which is as a rule associated with low tuber production.

Green manure crops increase the humus content and water holding capacity, improving the physical condition besides making a temporary increase in the acidity of the soil which is important in the control of scab. Fall rye gives good results as a green manure crop, especially following a clover sod that has been manured before ploughing. The rye should be turned under in the spring when it has made about 10 inches of growth. Buckwheat and barley may also be used, but must be ploughed under before hard freezing in the fall.

FERTILIZERS

On sandy loam soils without manure, or without a preceding crop of clover, use 4-8-10 using 750 to 1,000 pounds per acre.

In applying fertilizer on the fairly good types of potato soils, where manure has been used in amounts varying from 10 to 20 tons per acre as a top dressing on clover or old sod, the amount to be employed may vary from 750 to 1,000 pounds per acre of, say, a 2-8-10 or 0-12-15 commercial fertilizer. On heavier soils 2-12-6 may be used. This may be considered a very fair application. In cases where manure is not to be had, or where the land is low in plant food, the amounts of fertilizer may be increased by one-half. Where potatoes are grown extensively in certain parts of the Maritime Provinces, fertilizers are relied upon as a means of supplying the entire plant food requirements for the crop. Applications of from 1,500 to 2,000 pounds per acre are made, yielding profitable returns to the growers.

TABLE 3—FERTILIZER FORMULAE SUGGESTED FOR POTATO CROP*

(On average sandy loam)

Previous treatment of soil	Fertilizer materials per acre				Equivalent to (approximately)
	Nitrate of soda	Sulphate of ammonia	Sulphate of potash	Muriate of potash	
	lb.	lb.	lb.	lb.	
Clover sod liberally manured...	100	.....	325	60	500 pounds of 3–10–6.
Small dressing of manure.....	100	80	400	100	800 pounds of 4–8–6.
Clover sod, no manure.....	100	80	500	160	1,000 pounds of 3–8–8.
No clover or manure.....	150	120	600	190	1,200 pounds of 4–8–8.

* Shutt and Wright, bulletin No. 145, New Series.

The general recommendations in table 3 may be modified somewhat. On clay loam the potash may be reduced slightly, while on very light sandy loams it might be increased with profitable results. For muck soils, the fertilizer mixture should be high in phosphoric acid and potash. A 2-10-12 mixture might be found satisfactory.

EXPERIMENTAL FARM FERTILIZER RECOMMENDATIONS

The fertilizer recommendations made by the various Dominion Experimental Farms and Stations are as follows:—

Charlottotown, P.E.I.—The fertilizer mixture recommended in a 4-8-10† formula, using 750 pounds per acre. This amount is applied to supplement a light dressing of farmyard manure.

Fredericton, N.B.—In the fertilizer formula experiment conducted from 1922 to 1929, in connection with a three-year rotation consisting of potatoes, grain and hay, it was found that the largest average increase of merchantable potatoes was obtained where a 2,000-pound application per acre of a 4-8-10† mixture was used. The second largest increase was from a 2,000-pound application per acre of a 3-8-6 mixture. No manure had been applied to this land since 1921, when an application of ten tons per acre was made for a potato crop.

† See the Advisory Fertilizer Board recommendations published by the various Provincial Departments of Agriculture.

In the experiment dealing with the cost of producing potatoes, where a three-year rotation is employed, the fertilizer treatment consists of 12 tons of manure per acre with 1,000 pounds of a 4-8-10 commercial fertilizer.

It is true that farmers apply straight commercial fertilizer at the rate of 1,500 to 2,000 pounds per acre of a 4-8-10 mixture.

In another experiment it has been shown that where potatoes have been grown continuously on the same land for three years, using manure alone and fertilizer alone, there has been a progressive decrease in yield per acre. Where manure and fertilizer were used together, the yield of potatoes was maintained very well. The manure was applied at the rate of 8 tons per acre, and a 4-8-10 fertilizer was applied at the rate of 1,000 pounds per acre.

Ste-Anne de la Pocatière, Que.—The fertilizer mixtures suggested for this locality are the 3-8-8 mixture at the rate of 600 pounds per acre and the 5-8-10 mixture at 500 pounds per acre. These fertilizer mixtures were used in conjunction with barnyard manure in a three-year rotation of grain, clover hay and potatoes.

Agassiz, B.C.—In connection with the main crop of potatoes, a test of two fertilizer mixtures has been conducted to find what effect diminishing amounts of sulphate of potash would have. The ingredients and amounts in 1,500 pounds per acre are approximately as follows:—

	4-10-10	4-10-6
Nitrate of soda	97 pounds	97 pounds
Sulphate of ammonia	214 "	214 "
Superphosphate	937 "	937 "
Sulphate of potash	300 "	180 "

If applied at the rate of 750 pounds per acre the above figures are halved.

The average cost of fertilizer at Vancouver prices, during the four-year period, 1930 to 1933, has been as follows for the respective treatment:—

4-10-10 at 1,500 pounds per acre, $29.15.	4-10-10 at 750 pounds per acre, $14.75.	4-10-6 at 1,500 pounds per acre, $25.34.	4-10-6 at 750 pounds per acre, $12.67.

Potato prices at the time of digging, during the same period, have been respectively $30, $15, $10, and $20 a ton with an average price of $18.75.

In table 4 will be found the plot yields for each year, converted to an acre basis, the average yield for each treatment, over a five-year period, and the value of the crop, less the cost of fertilizer for the whole period.

TABLE 4—FERTILIZER EXPERIMENT WITH POTATOES

Year	4-10-10 at 750 pounds		4-10-10 at 1,500 pounds		4-10-6 at 750 pounds		4-10-6 at 1,500 pounds		Check plot no fertilizer	
	ton	lb.	ton	lb.	ton	lb.	ton	lb.	ton	lb.
1929	11	457	12	1,313	10	521	12	1,071	.....	
1933	12	938	14	1,856	12	1,891	15	1,581	3	688
1931	6	614	7	339	6	1,778	7	1,464	3	391
1932	4	1,292	5	980	4	1,492	5	635	2	1,481
1933	9	331	11	869	10	101	11	188	7	974
Total	43	1,632	51	1,357	44	1,783	52	939	18	1,534
Average yield	8	1,586	10	671	8	1,957	10	988	4	1,383*
Value of crop less cost of fertilizer	$150 30		$164 64		$155 68		$171 42		$87 97	

* Four-year average.

The results indicate that there has been a marked increase in yield and returns from fertilized plots as compared with the check plots, and that increased yields have resulted where 1,500 pounds per acre was applied as compared with 750 pounds per acre. It is shown that the increase is considerably less than the

increase between plots receiving no fertilizer and plots receiving 750 pounds. It is likely that an application of 1,000 pounds per acre would be the most economical amount for the soil conditions under which the experiment was conducted.

From this experiment it is evident that the 4-10-6 formula would cost less, with an average saving of $3.81 for the 1,500-pound application and $1.90 for the 750-pound application. The plots receiving the 4-10-6 formula have given higher average yields, with a correspondingly increased profit.

METHOD OF APPLYING FERTILIZER

The most economical method of applying fertilizer for the crop is with a potato planter. Commercial fertilizer should not be allowed to come in contact with the seed pieces in the soil on account of the danger of reducing the stand of plants. This injury is what is known as fertilizer burn.

The modern type of potato planter is equipped to place the fertilizer in the soil on either side of the sets, in strips or bands two inches wide, two inches distant from the sets and just level with, or slightly below, the sets. This is considered to be ideal.

Old-style planters were made to deposit the fertilizer in the soil below, or in very close contact with, the sets. New attachments may be obtained for many of these planters that will make it possible for the fertilizer to be deposited in the proper manner, or to broadcast part or the whole amount. Where a satisfactory distributor attachment is on the planter the whole amount of fertilizer can be most economically applied in one application.

SEED

It is important with the potato, as with other crops, that the best seed procurable be used for planting. The potato is subject to a great many diseases that on account of their peculiar character make it important that freedom from disease be emphasized. Certified seed represents the best that can be obtained and such seed can be relied upon to be as free from seed-borne diseases as possible, particularly those that are of a physiological nature. The diseases that are present in the tubers, and not visible to the eye, are the chief causes of degeneracy in the potato. Reference to these will be found in the section dealing with diseases. The common diseases, that are externally borne on the tubers, are easier to detect, and simple control measures may be used to rectify this condition prior to planting.

From experience it has been found that medium sized tubers make desirable seed. Tubers of medium size will be found to cut into better sets more economically than tubers of large size. Where certified seed is used, small sized tubers may be utilized with confidence. The use of small potatoes from the general bin run is a dangerous practice to follow, as it frequently happens that small potatoes are the result of some of the physiological diseases having been present. If small seed of this character is used, the loss in crop yield would consequently be heavy. The use of very large tubers as seed is not advisable, since the large tubers, due to their bulk, will produce fewer sets of a desirable size. In other words, a bushel of large potatoes will produce fewer sets than will a similar quantity of medium sized tubers.

Immature Seed.—It has been shown that by planting potatoes at various dates, starting as early as soil and weather conditions will permit, making the last planting on June 15, remarkable results can be obtained. From this test, conducted at the Dominion Experimental Farm, Agassiz, B.C., it has been shown that the best immature seed is obtained from the June 1 and 15 plantings. To test the value of the seed produced in this way, the seed from the various plantings harvested was planted on May 15 the following year, which is the average date for planting the main crop. It was found that the seed from the June 15 planting gave a consistently high yield.

The cost of producing seed in the above manner is quite high, but the increased yield obtained from the use of immature seed might be found profitable.

Seed potatoes that have been stored under warm conditions and have been sprouted while in storage will not produce as vigorous plants as seed that has been kept dormant until near planting time. The first sprouts from the eyes are much more vigorous than the secondaries.

The best storage temperature for seed tubers is 35°F. They may be stored in well constructed pits where the temperature will remain fairly constant or in a frost-proof storage where the temperature can be carefully regulated and the interchange of air controlled.

It is also important in the spring to remove the seed tubers from the storage cellar to a moderately warm place for the purpose of starting the buds. This should be done about two weeks prior to planting time. By this means a more uniform stand of plants can be depended upon. During this period treating for scab and rhizoctonia can be done. Since the varieties Katahdin and Chippewa appear to have weaker eyes at the stem end, the practice of warming up the seed or slightly sprouting will ensure an even stand of crop.

Local uncertified seed versus certified seed.

Size of Sets.—The most satisfactory size of sets for planting is from one and a half to three ounces and containing from one to three eyes. The sets should be cut so as to be blocky in form rather than thin or shallow pieces. During the period of growth, the potato plant is dependent upon the food supply in the seed piece to maintain it until the root system has become established. Cut seed is used to a very great extent in the large potato-growing areas, but to get best results the cut seed should be planted as quickly as possible after cutting. Cut seed pieces wither when exposed to the air for a few hours, and it has been found that where withering has occurred the stand of crop is rendered very uneven, with an associated drop in yield per acre at harvest time.

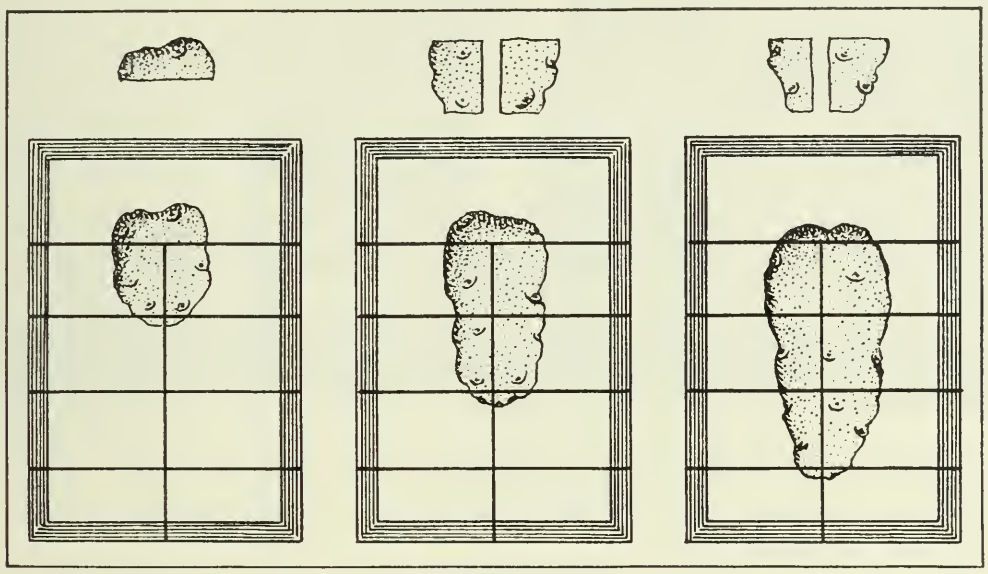
Cutting the Sets.—Several good makes of mechanical potato cutters are available, and when placed in the hands of careful workers can be operated with rapidity. The tubers can be cut into blocky sets in a very satisfactory manner. Some growers, however, prefer to cut the potatoes by the old hand method. While the sets may be cut more carefully by hand, by the mechanical method a larger amount of seed can be cut in a given time by the same amount of help.

Where it is found necessary to cut the seed pieces some time in advance of planting, this may be done if provision is made to avoid the undue loss of moisture from the sets. Sets that are cut for use several days prior to planting should be subjected to rapid suberization or corking over of the cut surfaces. This may be done by spreading the cut seed pieces out thinly under conditions of good ventilation and moderately warm temperature. Another method is to coat the cut surfaces with land plaster or flowers of sulphur. Once the cut surfaces are dried by any of the above methods, the sets may be stored in slatted bushel crates, in a cool place. Large containers should be avoided for fear of the sets heating.

It should be borne in mind that where cut seed is used, best results have been obtained where the freshly cut sets are planted in warm, moist well prepared soil.

Cutting seed pieces by foot power machine.

Whole Small Seed.—Whole small potatoes that weigh from two to three ounces will be found very satisfactory, provided of course they have been selected from healthy hills or stock. This type of seed will be found to give a more uniform stand of plants where planting is done in soils that are hot and dry. It has been shown that whole seed potatoes produce the largest yield, but the proportion of small unmarketable tubers is, as a rule, too great. Where whole seed is used, there is a tendency for a great many stalks to develop, which usually results in a struggle for plant food and moisture. The lack of plant food and moisture, under crowded conditions, results in the production of too great a proportion of unmarketable tubers.



Seed pieces cut by machine, showing method of placing the tubers on the knives.

Seed potatoes, taken direct from a cool storage cellar, and planted in cold, wet soil are more liable to rot. It is a good plan to warm seed potatoes prior to planting. In fact, if the buds are showing signs of slight development, much quicker and more uniform growth will result after planting.

During the past few years there has been an increased demand for seed for planting in remote places. To meet this, parcel post offered possibilities but excess weight had to be eliminated. Single-eye sets, known as potato eyes, and consisting of cylindrical pieces $\frac{3}{4}$ of an inch in diameter have been found satisfactory. These pieces contain one eye each, being cut completely through the tubers. After cutting, land plaster is immediately applied to the moist cut surface. Packed in slightly moist moss they may be shipped very successfully. If planted in well prepared warm soil, in the same manner as the regular type of sets very good results may be obtained.

THE BEST TIME TO PLANT

Regional conditions will govern the time when planting can be done to best advantage. The occurrence of late spring frosts must be considered, as well as the condition of the soil. It has been found that the earliest possible date at which planting can be done, climatic and soil conditions considered, has given the largest yields. This fact has been demonstrated by tests conducted in the Division of Horticulture. In regions where a long frost-free period occurs in the autumn, late planting may be employed with very satisfactory results.

The early, or first planting, referred to in this experiment is on May 26, from which 337 bushels 28 pounds per acre of marketable potatoes was the average yield for a six-year period.

The second planting on June 9 averaged 269 bushels 43 pounds per acre of marketable potatoes.

The third planting made on June 24 yielded 187 bushels 53 pounds per acre of marketable tubers. This would indicate that early planting is an important factor in influencing yield per acre. In the above test early varieties were used.

A further test was made with late varieties to find if the plantings made at the same dates would produce similar results on the crop returns.

The first planting yielded 319 bushels 9 pounds of marketable tubers per acre.

The second planting yielded 227 bushels 51 pounds per acre of marketable tubers.

The third planting yielded 160 bushels 4 pounds per acre of marketable potatoes.

DISTANCE APART TO PLANT

For average conditions 30 inches apart between rows is ample space, but, where high ridging is practised, 36 inches or more between rows will be found more satisfactory.

The most satisfactory distance between sets in the row is 12 to 14 inches. These distances have been found to give the best average yields. However, the early maturing varieties that do not make large foliage growth may be planted closer together in the row.

AMOUNT OF SEED

The amount of seed required to plant an acre will vary with the distance apart of the rows, the distance apart of the sets in the row and the size of the sets. If the sets are cut to one, two or three eyes or one, two or three ounces, the amount of seed will vary considerably.

With the rows spaced 30 inches apart and the sets dropped 10 inches apart, it would require 35 bushels per acre; 12 inches apart, 29 bushels per acre; 14 inches apart, 25 bushels per acre; and 16 inches apart, 22 bushels per acre. Where the rows are spaced 36 inches apart from four to six bushels less seed per acre would be required.

PLANTING

The amount of potatoes planted by machines has increased greatly during the past few years. While there is still considerable acreage planted by hand, in the highly specialized potato-growing sections machine planting is relied upon to a great extent. Several satisfactory makes of planters are available. These embody two distinct principles, the picker type and the cup and sprocket wheel spacer type. In the smaller models there are the one- and two-man machines. The one-man machine is cheaper to operate but the two-man machine, while costing more to operate, can be relied upon to produce a very uniform stand of crop, provided of course that good seed is available and other things are equal. Where very large acreages are planted, the two- three- and four-row platform machine planters are used to advantage.

A combined planter and fertilizer drill, single row picker type.

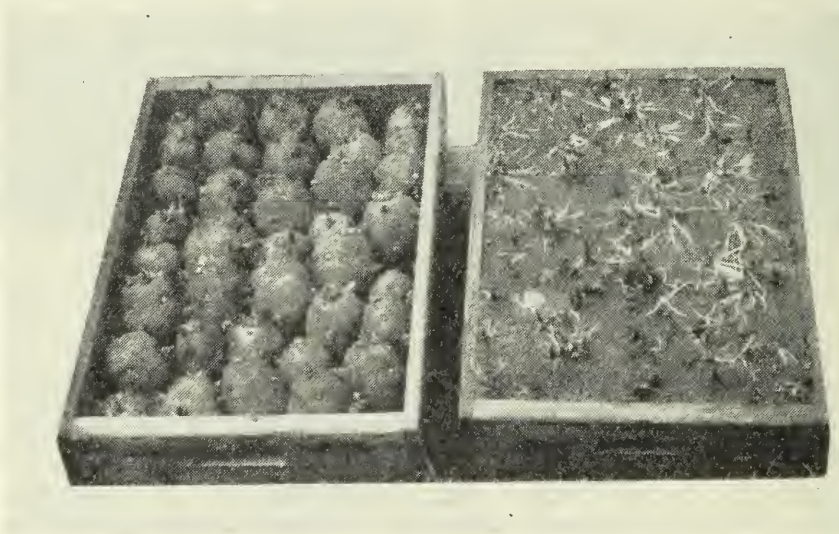
Where hand planting is done the land must first be ribbed up with a lister plough, also known as a double mouldboard plough. In fact the single mouldboard walking plough may be used but the work is not, as a rule, as evenly done. Dropping the sets by hand from a bag slung around the shoulder should be done while the soil is still moist. The sets are then covered by means of the lister plough, by splitting the ridges, or the ordinary single mouldboard plough may be used.

The methods of planting used prior to the advent of the mechanical planters are still in use by gardeners and growers of small acreages. In any event the preplanting preparation of the land should be carried out as previously outlined. The planting can be done to advantage in gardens by means of a hoe. Broad holes should be made to a depth of five or six inches, and spaced 13 to 15 inches apart, with the rows 30 to 36 inches apart. If commercial fertilizer is to be used it can be spread in the bottom of the holes, using one and a tablespoons per hole. This is approximately at the rate of 700 pounds per acre. To prevent what is known as fertilizer burn, one or two inches of soil should be placed on top of the fertilizer. One set or seed piece, containing two or three eyes, is placed on the soil in each hole, and covered to a depth of four inches.

Depth to Plant.—Depth of planting must be regulated according to the season of the year and the condition of the soil. For the very early crop, shallow planting is important. Sets dropped into cold, wet soil and covered deeply are liable to rot. As the season advances and the soil becomes warmer, the depth of planting and covering may be increased. The best average depth, however, has been found to be 4 inches.

SPROUTED SEED

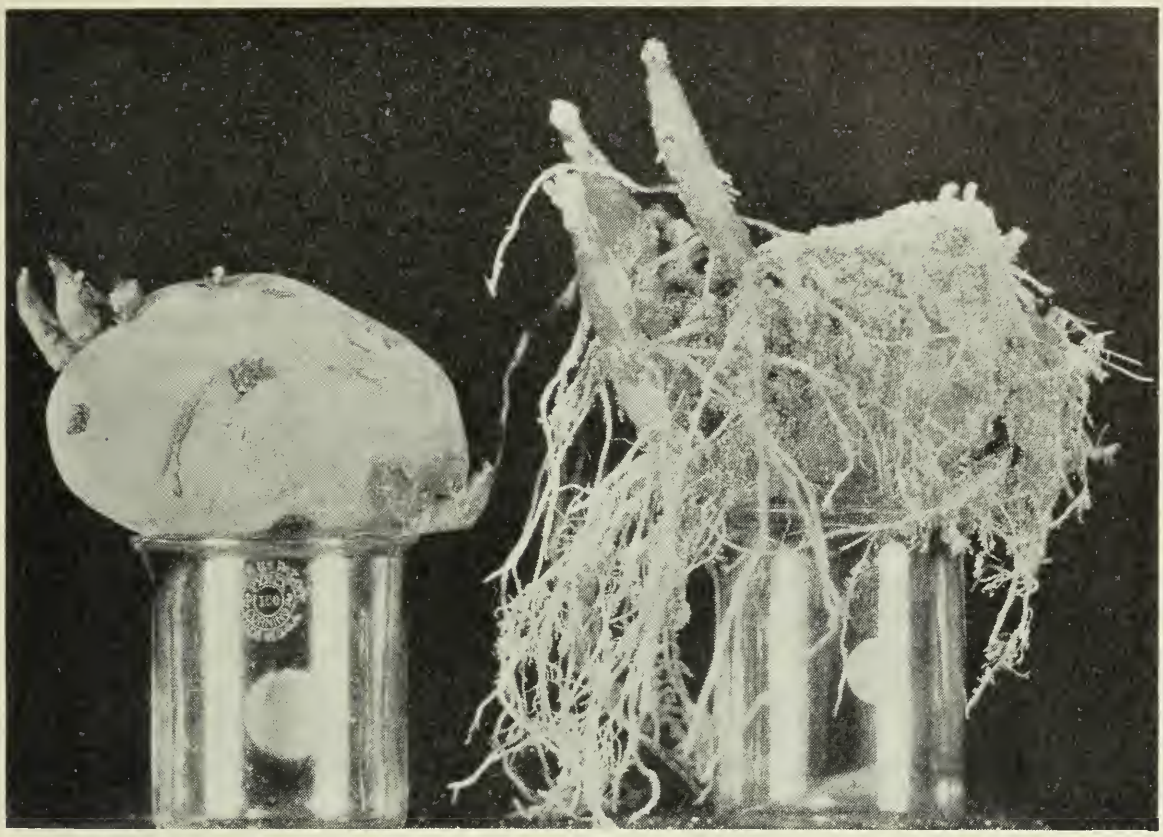
Sprouting seed potatoes prior to planting is employed to some extent for hastening the maturity of the early crop. The method commonly employed is to select small, or two- to three-ounce whole tubers and place them in a mild hotbed or cold frame or in a warm room where there is diffused light or in sprouting boxes with the rose or bud end up. Ordinary shallow fish boxes or hotbed flats may be used if the latter method is employed. Four pieces of one-inch square stake wood, three to four inches long, are nailed one in each corner of the flats, to provide spaces between the bottom and top of the flats when they are stacked one on top of the other. The space between the bottom and top allows light to enter. The flats are then placed in a temperature of from 55° to 60°F. In from three to five weeks strong, sturdy sprouts will have developed and, if soil and weather conditions are favourable, these sprouted potatoes may be



Sprouted in flats, without and with sand.

planted in shallow drills. If the sprouts are short and firmly attached to the tubers, the planting may be successfully done with the potato planter. Flat-sprouted seed, as a rule, is quite badly withered. This loss of moisture from the tubers is usually reflected in the top growth and yield produced.

Sand-sprouted potatoes will become established more rapidly after planting and give quicker results than those sprouted without a moisture-holding medium. Sand-sprouting consists of placing the tubers in flats, as previously described, and then filling dry river sand in around the tubers so as to slightly cover them. Water is applied to the sand immediately, and at intervals of once a week, or when required, to keep the sand moist. Three to five weeks of sprouting will develop sprouts and a very complete root system. Planting by hand is essential on account of the danger of injuring the roots. The sets can be planted at the regular depth, and soil filled in so as to cover the tips of the sprouts to a depth of one inch, or sufficient to give protection from the late frost. Seed treated in this way and planted when the soil is normally quite cool becomes established more quickly when growing conditions are right. Being sprouted and rooted, immediate root action takes place, which results in these plants having a very decided advantage over flat-sprouted or dormant seed.



Tubers sprouted in flats (left) without sand; note the withering; (right) in moist sand; note the roots developed and the firmness of the tuber.

In table 5 the results of an experiment with sprouted and dormant seed, conducted over a period of four years in the Horticulture Division, Central Experimental Farm, Ottawa, give a very good idea of what can be expected from an early potato crop.

TABLE 5—RESULTS OF EXPERIMENT WITH SPROUTED SEED

Treatment	Date planted	Date emerged	Date in full bloom	First digging		Second digging	
				Date	Yield per acre	Date	Yield per acre
					bush.		bush.
Sprouted in sand	May 13	May 25	June 23	July 25	272·6	Aug. 16	369·4
Sprouted in flats	" 13	" 29	" 27	" 25	156·4	" 16	242·7
Dormant	"	June 5	Aug. 2	.....	.....	" 16	239·7

In table 5 it will be noticed that the best average early yield was obtained from the seed tubers that were sprouted in moist sand prior to planting. Sprouting in flats without sand gave the next earliest yield but the difference between these two methods of sprouting is markedly in favour of sprouting in sand. In the case of the second diggings, sand-sprouted seed gave the best yield.

The dormant seed did not mature sufficiently for digging until August 16, or at second digging time. The yield was inferior to that from either of the previous treatments.

EARLY POTATOES

Different Dates of Digging.—There is a time to dig potatoes for early market to ensure obtaining the best returns from the plantation. This has been shown clearly by the results reported by the Dominion Experimental Farm, Agassiz, B.C. In this experiment, whole, small sprouted seed of the Early Rose variety was used. It has been found that the first marketable sized potatoes are formed at approximately the time of full bloom. In this experiment, digging was done at intervals of a week apart for eight weeks. It was found that there was a very marked increase in yield from week to week until the tops died, but for profitable early potato marketing the most satisfactory returns can be expected two weeks after the period of full bloom, or when the blossoms have practically all withered. By the end of the eight-week period, which is around the end of July, the yield per acre is much higher but the prices paid for early potatoes, as a rule, have decreased.

VARIETY RECOMMENDATIONS AND YIELD

Too much importance cannot be attached to the choice of varieties. In the past the tendency was for farmers to grow a great many varieties. This has been discontinued to a considerable extent, to the advantage of the producers of the best stocks. Zoning of varieties is to be recommended, that is, a certain number of growers in a locality should select one variety and grow that to the exclusion of all other varieties. Thus a certain locality will become well known for that variety of potato, or the growers may decide to grow two varieties, an early and a late crop variety.

The following recommendations concerning varieties and yields for the various regions in Canada have been made by the Dominion Experimental Farms and Stations and are based upon the results of extensive variety trials conducted for many years.

Charlottetown, P.E.I.—Irish Cobbler is a very popular early maturing white variety. Spalding Rose also does well as an early pink variety. Green Mountain is the best of the main crop varieties.

The fourteen-year average yield from Irish Cobbler is 268 bushels per acre.

Fredericton, N.B.—Irish Cobbler has proved the most satisfactory early white variety to date. Green Mountain is a good main crop white variety and is grown extensively in the province of New Brunswick.

Ste-Anne de la Pocatiére, Que.—Two white-skinned varieties are recommended: Irish Cobbler as an early variety and Green Mountain as the main crop variety.

Lennoxville, Que.—Three white-skinned varieties are recommended, Irish Cobbler for an early variety and Green Mountain and Dooley as the main crop varieties. The Dooley variety is gaining in popularity.

Ottawa, Ont.—Irish Cobbler is considered one of the best early varieties to grow. Gold Nugget, a yellowish-white-skinned variety of recent introduction has shown considerable promise. Warba is an important new variety that resembles Irish Cobbler in shape, differing by having pink eyes and maturing one week earlier. The keeping and cooking qualities are fair. Green Mountain and Dooley are important late varieties, but are being superseded by the new smooth, white varieties Katahdin and Chippewa. As well as being good yielders these two new varieties are resistant to mild mosaic.

Harrow, Ont.—In this part of southwestern Ontario the early potato crop is of more importance to the growers. Irish Cobbler is the most popular variety, but Early Ohio is also used in a limited way. Warba is proving useful. Two

main crop varieties are used to some extent, Dooley and Green Mountain (farther east in western Ontario), but are being superseded by Katahdin and Chippewa.

Kapuskasing, Ont.—The early variety, Irish Cobbler, is considered one of the best general purpose varieties for both the early and main crops. Green Mountain yields well, but is not considered so satisfactory as the former.

Morden, Man.—As early varieties, Early Ohio, and Early Favourite are two of the leaders. Early Ohio is sometimes used for the main crop as well. Burbank Russet or Netted Gem is also a very good main crop variety.

Brandon, Man.—The recommendations include Early Bovee and Early Ohio, two pink-skinned varieties for early cropping, and Green Mountain and Gold Coin as the main or late crop varieties.

Rosthern, Sask.—Irish Cobbler and Early Ohio are used for the early crop, while Irish Cobbler is also used for the main crop.

Scott, Sask.—Early Ohio and Bliss Triumph are the most satisfactory early varieties. For the main crop Irish Cobbler is recommended. During a five-year period, the average yield from Irish Cobbler was 127 bushels per acre.

Indian Head, Sask.—Irish Cobbler, Bliss Triumph and Early Ohio are recommended early varieties. Peachblow, Gold Coin, and Green Mountain are very satisfactory main crop varieties. Columbia Russet, originated at the Dominion Experimental Station, Windermere, B.C., has proved very productive.

Summerland, B.C.—Irish Cobbler, Early Rose, Early Ohio, Epicure and Bliss Triumph are the leading early varieties. Netted Gem is a good main crop variety.

Agassiz, B.C.—The best early varieties are Early St. George, Early Ohio, Epicure and Early Rose. The main crop varieties that have given best results are Green Mountain, Burbank and Netted Gem.

IMPROVEMENT

Constant vigilance on the part of the potato seed stock producers is necessary to maintain the most productive stocks. Reduced yield in the seed stock is equally fatal in general crop production.

The importance of special seed plot maintenance for the purpose of eliminating poor yielding and diseased progeny should be emphasized as it is the most satisfactory method known. There are five methods of maintaining the stock seed: (1) mass selection; (2) mass-hill selection; (3) pedigree-hill selection; (4) tuber-unit selection, and (5) certified foundation seed.

Mass selection of the tubers from the field rows at digging time, or from the bins in the storage cellar, has been employed far too extensively and is not recommended. The particular parent plants from which the tubers were selected not being known, leaves too much to chance.

Mass-hill and pedigree-hill selection are steps in the direction of recorded performance for each hill, during the season of growth, with regard to health of the growing plant and also the size, quality and yield of tubers from each hill. The presence of diseases in the plants can be detected in the leaves of the plants and also by the vigour of the plants. Where such hill selection is done the progeny of the best hills is used for multiplication the following year, using the seed as a bulk lot. It is also a good plan to save stock from the best producing hills, to be planted as in the former year, thus perpetuating the process of elimination of poor yielding material.

The tuber-unit system consists of selecting desirable tubers from the healthy, high yielding hills and dividing each of these tubers into four sets, which are planted in their respective order and given a number. Notes are taken on habit of growth, freedom from disease, and vigour of plants during the season of growth, as well as on the type of tubers and yield produced.

Careful isolation from all other potato stocks must be provided to remove the possibility of the spread of disease. Should the progeny of one hill from a tuber show the development of disease or undesirable characters, the progeny of the whole four hills from the parent tuber must be discarded. By this system of elimination, only the very best stocks will ultimately reach certification and become the basis for general field crop production. When this method of stock seed production is followed, hill selection from the general field crop is discontinued.

The latter two methods are recommended where disease-free high yielding stock is to be produced ultimately for certification.

For inspection and certification of seed stock, application should be made to the Plant Protection Division, Department of Agriculture, Ottawa, Ontario. The appended chapter entitled "The More Common Diseases of Potatoes" deals with the various phases of this work.

VARIETY ORIGINATION

The chief method of originating new varieties of potatoes is to grow them from the seed obtained from the tomato-like fruits produced at the tips of the potato vines. These potato balls or potato apples, as they are called, will be found in the autumn after the vines have ripened. These balls contain a considerable amount of small seed embedded in the pulp, that should be extracted by mashing the fruits or by cutting them in half and squeezing the seed out and washing in clean water by means of a fine sieve. When washing has been completed place the seed on clean white blotting paper or cheesecloth to dry. When dry, store the seed in seed envelopes.

To produce seedlings, in the following spring the seed should be sown thinly in pots or flats and placed in either a hotbed or a greenhouse. March seeding has been found quite satisfactory. When the seedlings have developed their first pair of rough leaves, they should be pricked out either in flats or a hotbed, spaced two inches apart each way. As soon as the plants begin to crowd in the flats or beds they should be transplanted singly into 4-inch pots or into quart-size strawberry boxes. Keep the plants in the hotbed, giving them the same treatment as tomato plants. Since the young potato plants are very tender and liable to damage from frost, they should be kept protected until the danger of chilly nights is past.

Planting in the field is done the same way as in the case of all pot-grown plants. The rows are spaced 36 inches apart with the plants spaced 24 to 30 inches apart in the row. Plenty of space should be allowed, since the habit of growth of each plant will vary considerably. Some of the plants may produce long stolons which would be the cause of the progeny becoming mixed in the hills, if closer planting was employed.

Hardly two plants in a large population of seedlings will be alike and in this respect each plant, with the progeny, must be treated as a separate variety throughout the season of growth. Notes are taken on habit of growth and other detailed information is recorded that would be useful in connection with the tuber selection. The usual cultivation and spraying will be all that will be necessary. When the plants have matured, the progeny of each plant should be carefully dug and kept together. Selection for tuber shape, colour, depth of eyes, and yielding ability should be carried out. The tubers from each hill should be placed in a separate cotton or paper bag, with the necessary identi-

fication tags attached to these containers. The tubers are stored in the usual way and in the following spring these selected progenies are each treated as a separate variety and the performance of each checked in the following years.

In the Division of Horticulture, Central Experimental Farm, Ottawa, Ontario, seedling potatoes have been grown that produced tubers in the first season weighing between nine and ten ounces. The hill yields ranged from a few ounces up to five pounds fifteen ounces. In addition, the vines of some of these plants produced seed balls in the first season.

Sturdy seedling plant grown from seed sown on March 31. Ready for planting out at the end of May.

To obtain one worthwhile new variety may require the growing of many thousand seedlings. Growers of these seedlings should be patient and not too anxious to name and introduce a so-called variety that may not possess any better, if as good, qualities as the now well known varieties.

The field of plant breeding will no doubt accomplish considerably more, where the parent varieties are carefully selected and observed and combinations made for a specific purpose. The technique of this work, however, is beyond the limitations of this publication.

GROUP CLASSIFICATION OF POTATOES

The same variety of potato is often sold under several different names and, on the other hand, some varieties, though of different origin, are so much alike that one cannot with certainty distinguish between them. It has seemed best, therefore, to divide potatoes into groups of varieties, and possible synonyms, having certain characters in common. By this method, if varieties are sold under different names, anyone may test those of the same group, side by side, and learn for himself what differences, if any, there are between them. Often the difference in the vigour of the seed is of greater importance than the difference between the so-called varieties.

The best group classification for varieties of American origin is that given by Prof. Wm. Stuart, potato specialist of the Bureau of Plant Industry, Department of Agriculture, Washington, D.C., in bulletin No. 176, Bureau of Plant Industry, entitled "Group Classification and Varietal Descriptions of some American Potatoes," and as the writer believes that it is desirable to have the same classification adopted for all America, if possible, Prof. Stuart's "Classification Key" with names of varieties or synonyms of each group, which have come under the writer's notice in Canada, are herewith given.

CLASSIFICATION KEY

"GROUP 1—COBBLER.

Tubers: Roundish; skin creamy white.
Sprouts: Base, leaf scales, and tips slightly or distinctly tinged with reddish-violet or magenta. In many cases the colour is absent.
Flowers: Light rose purple; under intense heat may be almost white."
Varieties: Early Petoskey, Extra-Early Eureka, Irish Cobbler.

"GROUP 2—TRIUMPH.

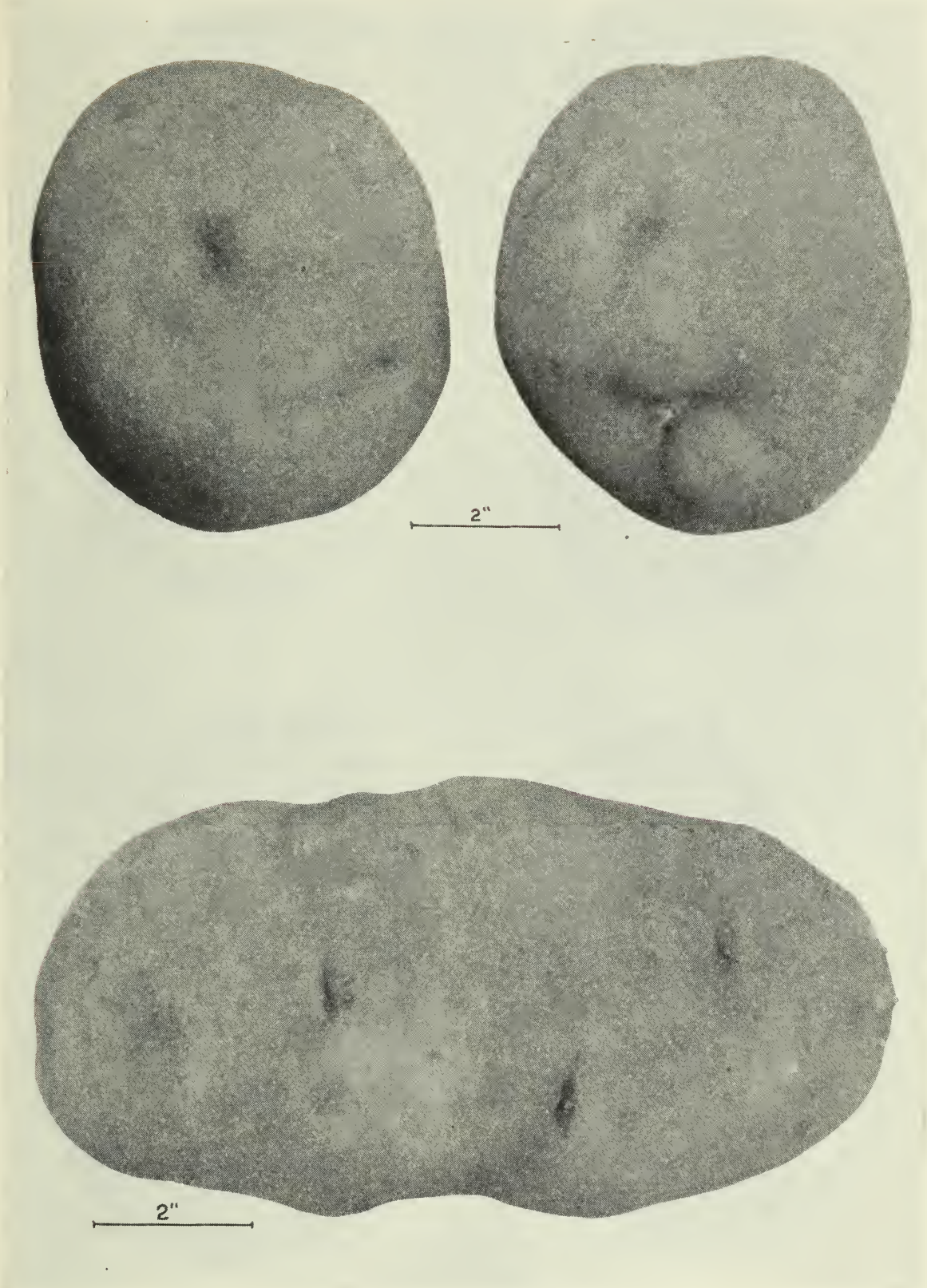
Tubers: Roundish, skin creamy white, with more or less numerous splashes of red, or carmine, or solid red; maturing very early.
Sprouts: Base, leaf scales, and tips more or less deeply suffused with reddish violet.
Flowers: Very light rose purple."
Varieties: Bermuda Early, Noroton Beauty, Quick Lunch (Uncle Gideon's), Bliss Triumph, Stray Beauty.

"GROUP 3—EARLY MICHIGAN.

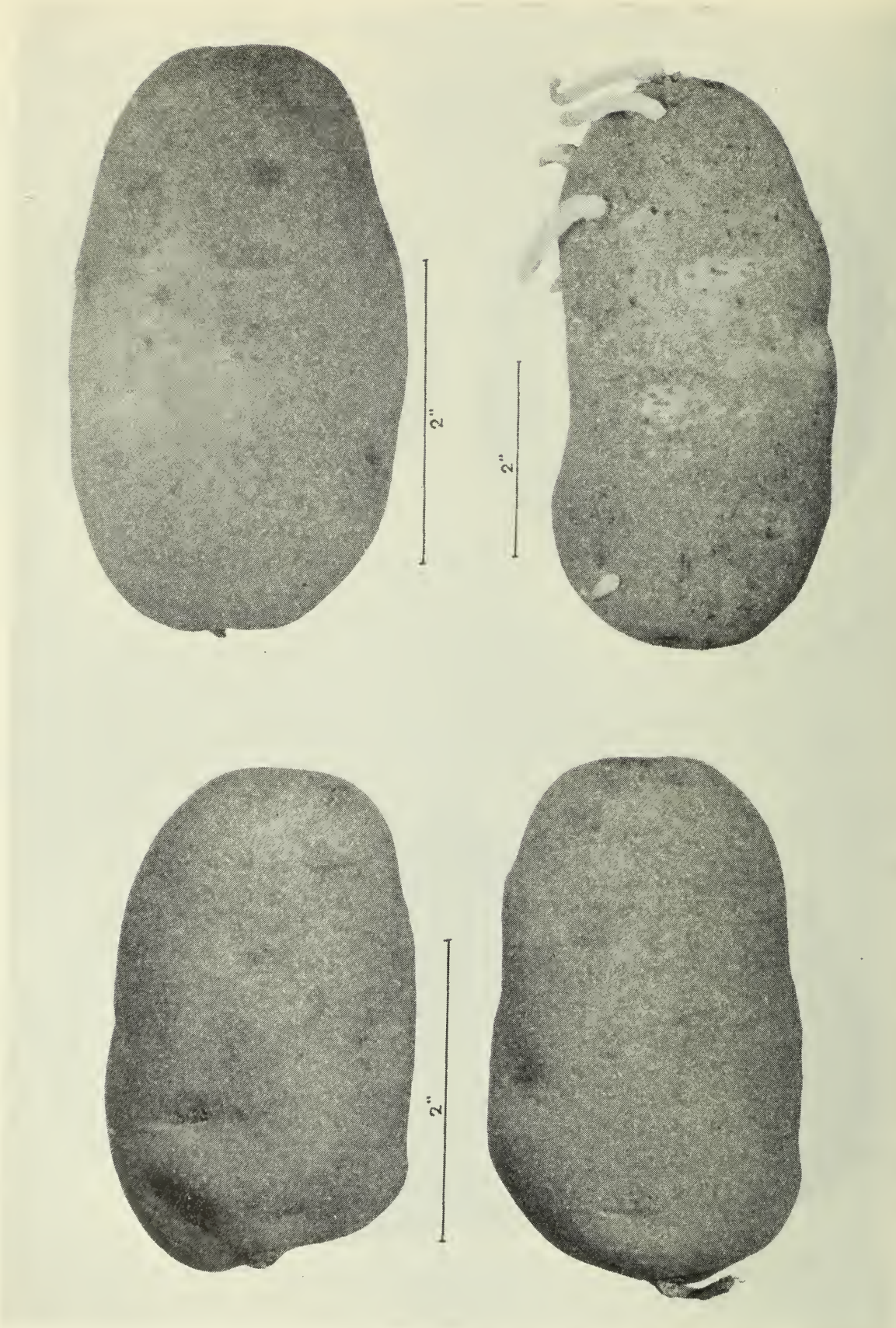
Tubers: Oblong or elongate-flattened; skin white or creamy white, occasionally suffused with pink around bud-eye cluster in Early Albino.
Sprouts: Base light rose purple; tips creamy white or light rose purple.
Flowers: White."
Varieties: Early Albino, Early Michigan, Early Puritan, Early White Prize, Woodbury White Rose.

"GROUP 4—ROSE.

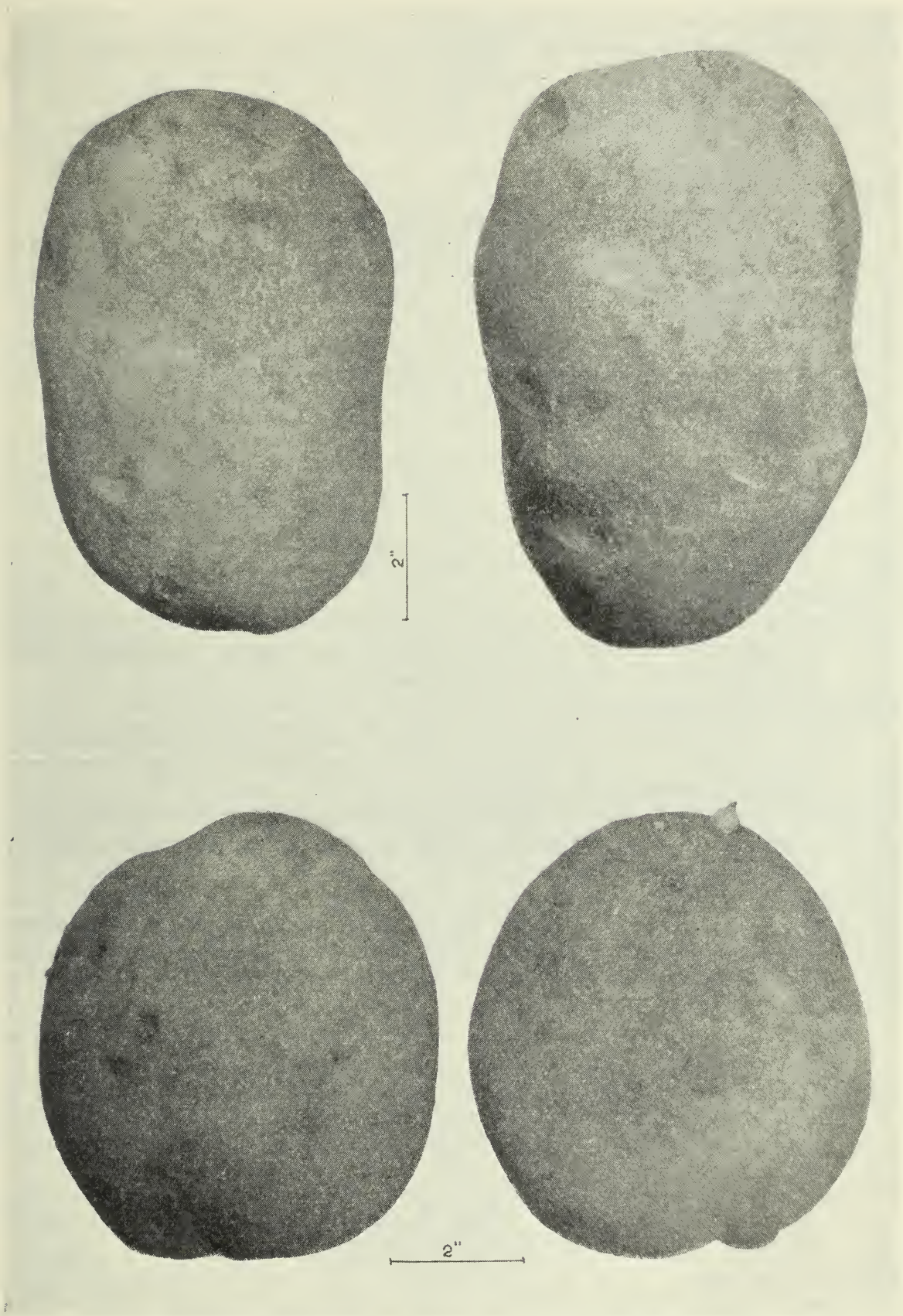
Tubers: Roundish oblong to elongate-flattened, or spindle-shaped flattened; skin flesh-coloured or pink, or (in the case of the White Rose) white.
Sprouts: Base and internodes creamy white to deep rose lilac; leaf scales and tips cream to rose lilac.
Flowers: White in sections 1 and 2; rose lilac in section 3."
Varieties: Section 1, Clark No. 1, Early Fortune, Early Norther, Early Rose, Early Sunrise, Early Thoroughbred, Everitt, Extra-Early, Vermont, Houlton Rose, Late Rose, Northern Beauty, Rochester Rose; Section 2, Manistee; Section 3, Crine Lightning, Lee Favourite, New Ideal, New Scotch Rose, Seneca Beauty.



Upper, Irish Cobbler; lower, Early Rose.



Upper left, Burbank; upper right, Netted Gem; lower, Early Ohio.



Upper, Green Mountain; lower, Dooley of the Rural Group.

"Group 5—Early Ohio.

Tubers: Round, oblong, or ovoid; skin flesh-coloured or light pink, with numerous small, raised russet dots.

Sprouts: Base, leaf scales, and tips more or less deeply suffused with carmine lilac to violet lilac or magenta.

Flowers: White."

Varieties: Early Ohio, Early Market, Early Six Weeks, White Ohio, Ohio Junior.

"Group 6—Hebron.

Tubers: Elongated, somewhat flattened, sometimes spindle-shaped; skin creamy white, more or less clouded with flesh colour or light pink.

Sprouts: Base creamy white to light lilac; leaf scales and tips pure mauve to magenta but colour sometimes absent.

Flowers: White."

Varieties: Country Gentleman, Crown Jewel, Early Beauty of Hebron, Early Bovee, Gem of Aroostook, Harbinger, Late Beauty of Hebron, New Queen, Quick Crop, White Elephant, Morgan Seedling.

"Group 7—Burbank.

Tubers: Long, cylindrical to somewhat flattened, inclined to be slightly spindle-shaped; skin white to light creamy white, smooth and glistening, or deep russet in the case of section 2.

Sprouts: Base creamy white or faintly tinged with magenta; leaf scales and tips usually lightly tinged with magenta.

Flowers: White."

Varieties: Section 1, Burbank, or Burbank Seedling, Money-Maker, White Beauty, White Chief; Section 2, California Russet, Cambridge Russet, New Wonderful, Hammond Wonderful.

"Group 8—Green Mountain.

Tubers: Moderately to distinctly oblong, usually broad, flattened; skin a dull creamy or light russet colour, frequently having russet-brown splashes towards the seed end.

Sprouts: Section 1, base, leaf scales, and tips creamy white; Section 2, base usually white, occasionally tinged with magenta, leaf scales and tips tinged with lilac magenta.

Flowers: White."

Varieties: Carmen No. 1, Clyde, Delaware, Dooley, Empire State, Freeman, Gold Coin, Green Mountain, Green Mountain, Jr., Norcross, Snow, State of Maine, Uncle Sam; Section 2, Charles Downing.

"Group 9—Rural.

Tubers: Broadly round-flattened to short oblong, or distinctly oblong-flattened; skin creamy white, or deep russet in the case of section 2.

Sprouts: Base dull white; leaf scales and tips violet purple to pansy violet.

Flowers: Central portion of corolla deep violet, with the purple growing lighter toward the outer portion; five points of corolla white, or nearly so."

Varieties: Carman No. 3, Dooley (as grown in western Ontario), Great Divide, Million Dollar, Noxall, Rural New Yorker No. 2, Sir Walter Raleigh, White Giant; Section 2, Dibble Russet.

"Group 10—Pearl.

Tubers: Round-flattened to heart-shape flattened, usually heavily shouldered; skin dull white, dull russet, or brownish white in section 1, or a deep bluish purple in section 2.

Sprouts: Section 1, base, leaf scales, and tips usually faintly tinged with lilac; Section 2, base, leaf scales, and tips vinous mauve.

Flowers: White."

Variety: Pearl: Section 2, Blue Victor.

"Group 11—Peachblow.

Tubers: Round to round-flattened or round-oblong; skin creamy white, splashed with crimson or solid pink; eyes usually bright carmine. Includes some early-maturing varieties.

Sprouts: Base, leaf scales, and tips more or less suffused with reddish violet.

Flowers: Purple."

Varieties: Improved Peachblow, Peachblow, Nott Peachblow.

DESCRIPTION OF VARIETIES

Popular descriptions have been made of the varieties which have yielded best at the Dominion Experimental Farms and Stations in Canada and of additional varieties that are interesting for other reasons. Included in the descriptions will be found the names of other well-known varieties closely resembling, if not identical with, those which are described. The information in regard to the origin of these varieties has been taken almost entirely from bulletin No. 176 of the Bureau of Plant Industry, Washington, D.C., by Wm. Stuart, who has especial facilities for tracing them out.

Bliss Triumph.—One of the earliest varieties. It is rather a poor yielder in many places in Canada but in the best potato districts it is sometimes grown for seed for the growers in Bermuda, where it is a popular variety for shipping to American markets during the winter months. Bermuda Early and Stray Beauty are apparently other names for this variety, which originated in Connecticut and was introduced by B. K. Bliss & Sons, in 1878. It was claimed to be a seedling of Peerless crossed with a seedling of Early Rose. The vine of this variety is quite erect and the foliage of a deeper green than that of most potatoes. The tubers are rarely above medium size, roundish in shape and red in colour; the eyes are medium in depth.

Bovee.—This early variety, which has done well in many places, is very similar to the Early Beauty of Hebron, the latter being seldom found now, most of the Beauty of Hebron grown apparently being the late type, such as White Elephant. Other early varieties, much like Bovee, are New Queen, and Vick Extra Early. Bovee, or Early Bovee, originated as a seedling with Martin Bovee, Northville, Michigan, some years after the Early Beauty of Hebron was introduced, the latter having been originated by E. L. Coy, Hebron, N.Y., and claimed to be a seedling of Garnet Chili. The Early Beauty of Hebron was introduced in 1878 by J. M. Thorburn & Co., New York. Season early; plant a strong grower, and productive. Tubers oblong to oval; colour pink and yellowish; eyes moderately numerous, medium in depth.

Burbank (seedling).—The Burbank potato is most popular in Nova Scotia and in British Columbia, where it has succeeded very well. The Money Maker is very similar and so is Selina Burbank, originated by Luther Burbank in 1873 and claimed to be a seedling of Early Rose.. Burbank was introduced by J. J. H. Gregory in 1876. Season medium late; plant a strong grower; tubers long, cylindrical; skin dull white; eyes shallow to medium.

Carman No. 3.—Originated by E. S. Carman in 1888. Claimed to be a seedling of a seedling. Introduced in 1895 by J. M. Thorburn & Co. This variety has yielded well in some parts of Canada. Season late; plant a strong grower; tubers oval to roundish, somewhat flattened; skin creamy white; eyes comparatively few and shallow. Good in quality.

Dooley.—"Originated from one hill of potatoes selected in the field in Waupaca county, Wisconsin, 1896; introduced by Gunson, Brown & Co., in 1900." (Zavitz.) A strong grower; tubers oval, flattened; skin creamy white; eyes medium to shallow. Quality good. Has yielded well in places.

Early Ohio.—Originated by Alfred Reese in 1871, and claimed to be a seedling of Early Rose. Introduced by J. J. H. Gregory in 1875. The Early Ohio continues to be grown fairly extensively in Canada and particularly in the provinces of Ontario and Manitoba, where it is highly regarded for early digging for city markets, a large proportion of the early tubers being of good size and the quality of the potatoes exceptionally good. It is not, however, as productive as the Irish Cobbler. Season very early; a strong to medium grower; tubers round-oblong, not tapering at the ends like many varieties, but being almost uniformly thick from one end to the other; skin light pink, deeper in colour at seed end; eyes moderately numerous, shallow or protruding. Quality good.

Early Rose.—The Early Rose, Rochester Rose, Everitt, Early Northern, Early Hero, Houlton Rose, Reeves Rose, Clark No. 1, Early Fortune, Early Thoroughbred, Early Sunrise, Extra Early Vermont and others are all so much alike that they may be treated as one variety. It seems very probable that most of these are merely selections from the Early Rose which have lost their distinguishing characteristics.

The Early Rose was originated by Albert Bresee, Hubbardton, Vermont, in 1861, and was claimed to be a seedling of the Garnet Chili. Introduced in a limited way in 1867 by D. S. Heffron, Utica, N.Y., and to the general public by B. K. Bliss & Sons in 1868, since which time it has been very popular and while in recent years it has been displaced to a considerable extent by a few other early and more productive varieties, it is still planted to a large extent under this or some other name. It is a vigorous grower and under favourable conditions produces a good crop. The tubers are oblong to long, pink in colour, with eyes of medium depth. The eyes, which are fairly numerous, usually sprout strongly from one end of the tuber to the other, thus ensuring a good stand of plants. The quality is, as a rule, good, the tubers cooking dry and mealy.

Early White Prize.—An early white skinned variety, oblong to long in shape and with eyes of medium depth. Quality good.

Empire State.—The Empire State has long been a popular variety in Canada, especially in the province of Ontario, and yields well on the average. The American Wonder is very similar to it. While included in the Green Mountain group it is quite distinct from most of the other varieties of the group. It was originated by E. L. Coy, Hebron, N.Y., in 1881 and claimed to be an inbred seedling of White Elephant. Introduced by W. A. Burpee in 1885. Season medium to late; plant a strong grower and productive; tubers oblong to long, white, with numerous medium to deep eyes, most of which usually throw strong sprouts.

Garnet Chili.—In Canada, the Garnet Chili is mainly grown in the Maritime Provinces where it is raised especially for seed for the Bermuda growers. It was originated by C. E. Goodrich, Utica, N.Y., in 1853 and claimed to be a seedling of Rough Purple Chili. Introduced by Goodrich in 1857. Season late; plant a strong upright grower; tubers roundish to oblong, flattened at ends; skin red; eyes medium in depth.

Green Mountain.—This variety represents the most important group of potatoes cultivated in Canada. They are all medium to late in season and the bulk of the potatoes stored for winter use are of this group. There are many varieties very similar in appearance including Carman No. 1, Clyde, Gold Coin (Vermont), Delaware, Dreer Standard (not Dreer Early Standard), Green Mountain, Green Mountain Jr., Norcross, Snow, State of Maine, Uncle Sam and Wee MacGregor. American Wonder and Empire State which are included in this group are quite distinct from the others being longer in shape. The Green Mountain variety is grown more in the Maritime Provinces than any other. In Ontario and Quebec, Carman No. 1 and Gold Coin, which cannot be distinguished from the Green Mountain, are, perhaps, the most common, though

the quantity of Green Mountain grown in recent years has increased rapidly as much seed has been sent from New Brunswick. On the prairies the Gold Coin and Wee MacGregor are best known, the latter originating with T. Rowan, MacGregor, Man.

Green Mountain was originated by O. H. Alexander, Charlotte, Vermont, in 1878 and is claimed to be a seedling from a cross between Dunmore and Excelsior and was introduced by Everitt & Co., in 1885. It is a strong grower and a good cropper, but does not retain its vigour so well as some varieties under trying conditions. The tubers are oblong in shape, inclined to be blocky or flattened at the ends, and white or creamy in colour with more or less russet. The eyes are moderately numerous and medium in depth.

Irish Cobbler.—Origin unknown, but supposed to have been first grown by an Irish shoemaker in Marblehead, Mass. Sold by Vaughan Seed Company in 1895. This is the most popular early potato grown in Canada. It is both early and productive and maintains its vitality better than many other varieties. The Eureka Extra Early cannot be distinguished from this, although claimed to have been originated by Geo. R. Pedrick of New Jersey in 1895 and claimed to be a sport of Early Morn. While not of the best shape, and eyes being rather deep, it has, by its regularity in producing good crops, displaced to a large extent more attractive looking varieties. It is easy to distinguish this from the white flowered varieties of the Green Mountain group in the field, if it should get mixed with them, as it has purple flowers. Season early; plant a strong grower; foliage deep green in colour; tubers roundish, flattened somewhat at ends; skin creamy white; eyes moderately numerous and medium to deep. Quality good.

Late Puritan.—This is very similar to Early Puritan and is medium in season rather than late; oblong in shape and with numerous eyes of medium depth. Quality good.

Lion Paw.—An oval, white potato which has succeeded well at the Experimental Station, Charlottetown, P.E.I.

McIntyre.—The McIntyre potato is grown mainly on Prince Edward Island where it is very popular on account of its yield and good shipping qualities Season late; plant a strong grower; tubers long to oval, irregular; colour of skin yellowish mottled with pinkish-purple to purple; eyes numerous, medium to deep; quality good when well matured.

Manistee.—This variety is somewhat similar to Maggie Murphy. Introduced by E. F. Dibble in 1904.

Million Dollar.—A white skinned potato of unknown origin introduced by the Salzer Seed Company.

Moreton.—An oval, flattened, white skinned potato with shallow eyes which has yielded exceptionally well at Ottawa and was procured from the firm of Joseph Harris, Coldwater, N.Y.

Morgan Seedling.—This and a white seedling were sent to the Central Experimental Farm in 1904 by the Family Herald and Weekly Star, Montreal, which had received them from H. H. Morgan, Manchester, N.H., under the name of "Morgan Seedling." It is a variety of the Hebron group, which has yielded very well in different parts of Canada. Season medium; plant strong grower; tubers oval to long; colour of skin pink and yellowish; eyes moderately numerous, medium in depth. Quality good.

New Scotch Rose.—Claimed to have been introduced from Scotland by an American firm. Plant a strong grower; season medium early; tubers oblong to oval flattened; colour of skin pink; eyes few and medium in depth. Resembles Maggie Murphy somewhat.

Netted Gem.—This variety is now much grown in British Columbia and, on account of its handsome appearance, good quality, and productiveness, is very popular there. Other varieties very closely resembling, if not identical with it, are California Russet, Cambridge Russet, New Wonderful and Hammond Wonderful. Origin unknown. Season late; plant a vigorous grower; tubers long to oval, elongated; skin russet-brown, finely netted; eyes shallow.

Pride of the North.—A variety of unknown origin which has done well in the Eastern Townships of the province of Quebec. Season medium to late; plant a strong grower and productive; tubers oval; flattened; skin pale pink, brighter in eyes; eyes few to moderately numerous, medium in depth to shallow.

Rawlings Kidney.—Origin unknown. Tubers sent to the Central Experimental Farm by Heber Rawlings, Forest, Ont., in 1904, under the name of "Ashleaf Kidney," but not being typical Ashleaf Kidney this variety has been called Rawlings Kidney. It is much like Green Mountain and Gold Coin. It has succeeded particularly well in the Prairie Provinnces. Season medium late; plant a strong grower; tubers oval to oblong; colour of skin yellowish; eyes moderately numerous; medium in depth. Quality good.

Rural New Yorker, No. 2.—Originated by E. S. Carman. Introduced to Rural New Yorker subscribers in 1888 and offered for sale by J. M. Thorburn & Company in 1889. A seedling of seedlings, through several generations. Season medium late; plant vigorous; tubers oblong to round-oval, somewhat flattened; skin white, eyes few, medium to shallow; quality good.

Sir Walter Raleigh.—Originated by E. S. Carman. Claimed to be a seedling of the Rural New Yorker No. 2. Introduced by Peter Henderson in 1897. A productive variety in some parts of Canada. Season late; plant a strong grower; tubers roundish-oval; skin creamy white; eyes scattered and medium to shallow in depth. Good in quality.

Woodbury White Rose.—A moderately early, white skinned variety of oblong shape and moderately deep eyes; a variety which has done well in Manitoba.

VARIETIES OF BRITISH ORIGIN

During the past 30 years several hundred varieties of potatoes of British and European origin have been tested at the Central Experimental Farm. The great majority of these proved unproductive, many of them setting very few tubers. The climate at Ottawa was evidently unsuitable for them. A few, however, have succeeded very well at Ottawa and elsewhere. Some of them are able to retain their vitality while such American varieties as the Green Mountain, Early Rose, Early Ohio, and others have become very weak in vitality under similar conditions. Brief descriptions of these follow. Some of them are very much alike. The quality of most of these varieties is good.

Brydon.—Season medium late; plant a strong grower; flowers violet; tubers oval-elongated; colour of skin dull yellow; eyes few to medium, shallow.

Brydon Beauty.—Season medium late; plant a strong grower; flowers violet; tubers nearly ovoid; colour of skin white; eyes few, shallow.

Conquering Hero.—Season late; plant a strong grower; flowers purple; tubers oval-elongated; skin yellow; eyes few, medium in depth.

Dalmeny Beauty.—Season medium; plant a strong grower; flowers pinkish white; tubers oval; skin yellow; eyes few, shallow.

Dalmeny Hero.—Season medium; plant a strong grower; tubers oval, flattened; skin yellow; eyes few, shallow.

Dalmeny Regent.—Season medium; plant a strong grower; flowers purple; tubers oval; skin yellow, eyes few, shallow.

Davies Warrior.—Season late; plant a strong grower; flowers violet; tubers oval-elongated; flattened; skin yellow; eyes few, shallow. This variety has

done exceptionnally well in the province of Ontario, and has been widely distributed by the Ontario Agricultural College.

Dobbie Prolific.—Season late; plant a strong grower; flowers violet; tubers oval, flattened; eyes few to moderately numerous; shallow.

Epicure.—Season medium early; plant a strong grower; flowers white; tubers roundish; colour pale pink; eyes many, deep.

Factor.—Season late; plant a strong grower; flowers purple; tubers oval, flattened; skin yellow; eyes few, shallow.

Scot (The).—Season late; plant a strong grower; flowers violet; tubers oval, flattened; skin yellow; eyes few, shallow.

Scottish Triumph.—Season late; plant a strong grower; flowers pale violet; tubers roundish oval, flattened; skin yellow; eyes few, shallow.

Table Talk.—Season late; plant a strong grower; flowers deep violet; tubers oval-elongated; skin yellow; eyes few, shallow. This variety was first disseminated to any extent in Canada by the Experimental Station, Lacombe, Alberta, and has since been found to succeed well in all the provinces of Canada. It is of good quality and very productive.

Up-to-date.—Season late; plant a strong grower; flowers violet; tubers oval; skin yellow; eyes few, shallow to medium in depth.

VARIETIES OF RECENT ORIGIN

In the following will be found descriptions of several new varieties that have been under observation and test during the past few years. Where possible the originators description has been used for the purpose of continuity of terminology.

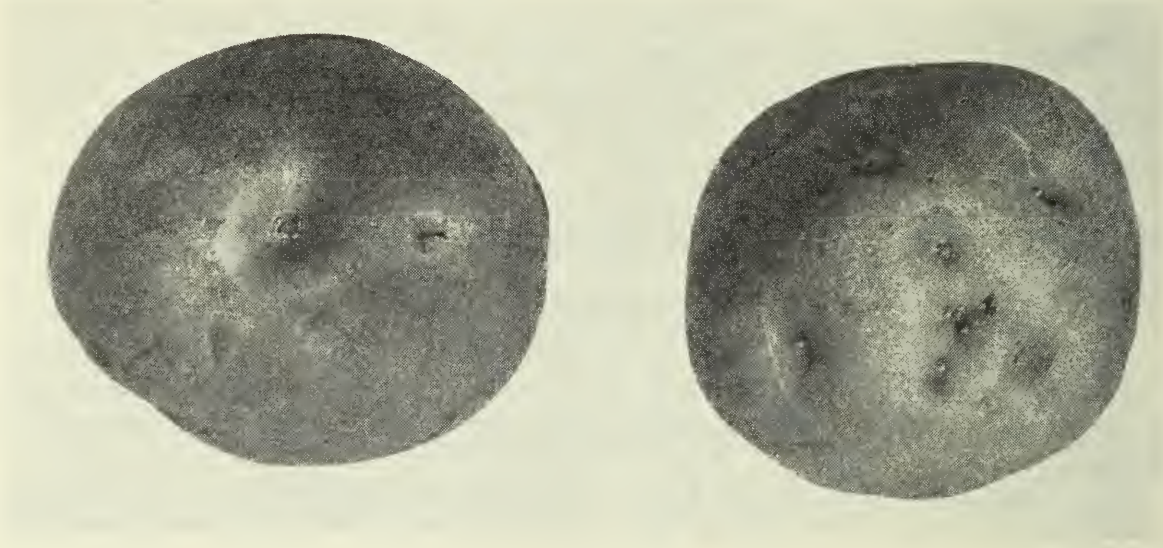
Gold Nugget.—The variety Gold Nugget, was selected from Irish Cobbler, by Dr. Seager Wheeler, Rosthern, Sask. The plants are moderate growing with medium to pale green foliage. The flowers are cream to white. Tuber shape is much the same as Irish Cobbler, but with shallower eyes. The skin is of a yellowish tinge with the lenticels widely separated. In season it is slightly earlier than Irish Cobbler and performs much the same.

Gold Nugget

Adaptation

Gold Nugget has a place as an early variety for local market and home gardens.

Warba.—The new variety Warba developed at the Agricultural Experiment Station, Minnesota from a cross of Bliss Triumph with a selected seedling known as Minnesota 4—16. This variety is extra-early maturing resembling Bliss Triumph except for its white skin. The eyes are numerous, fairly deep, though not as deep as Irish Cobbler. The skin colour about the eyes is pink, inherited from Bliss Triumph. The tubers are blocky in shape and the flesh is very white, fine in texture with good quality. The season for Warba is 10 to 14 days shorter than Irish Cobbler. It is reported as very resistant to mosaic.



Warba

Adaptation

As an early variety for local market and home gardens, Warba offers much promise.

KATAHDIN, CHIPPEWA, AND GOLDEN[1]

The Katahdin[2] and Chippewa[3] potatoes were produced as the result of a plant-breeding program, one phase of which has for its definite purpose the production by hybridization and selection of varieties of potatoes resistant to a virus disease known as mild mosaic.

When potato breeding was actively undertaken by the United States Department of Agriculture in 1910 the only disease resistance sought was that against the late-blight fungus (*Phytophthora infestans* (Mont.) DBy.). It was not until some years later that it became evident that the virus diseases were a vastly greater menace to potato production than late blight, because of the fact that potato viruses are transmitted from one crop to the next through tuber infection and, in addition, they cannot be controlled by fungicidal application to the foliage or by seed treatment.

The widespread occurrence of potato virus diseases, such as the various types of mosaic, leaf roll, spindle tuber, unmottled curly dwarf, and streak, necessitates the development of varieties resistant to such diseases. The first step in this direction was toward the develpment of varieties resistant to one of the most common virus diseases in Maine, mild mosaic.

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[1]Circular 374, U.S. Department of Agriculture. The Katahdin and Chippewa Potatoes, by C. F. Clark and F. J. Stevenson.

[2] The name of the highest and most prominent mountain in Maine, the State in which this variety originated. This name is of Indian origin and signifies "venerable mountain."

[3] The name of a tribe of Indians who occupied the region from Lake Huron to North Dakota.

KATAHDIN

Description

Plants medium to large, spreading; stems thick, prominently angled; nodes slightly swollen, green; internodes slightly reddish purple or green; wings slightly waved or straight, green; stipules large, green, glabrous; leaves very long, broad, midrib green and scantily pubescent; primary leaflets close, medium green, 4 pairs, large, ovate, mean length 77·23±0·55 mm (3·04 inches), mean width 49·07±0·38 mm (1·93 inches), index 63·54±0·27[4]; petioles green; secondary leaflets many, three positions—on midrib between pairs of primary leaflets, at junction of midrib and petioles of primary leaflets, on primary leaflet petioles; tertiary leaflets medium to many in number; inflorescence much branched, leafy bracts none; peduncles short to medium, pubescence scant; pedicels medium to long, green, pubescence scant.

Flowers.—Calyx lobe tips long, little pigmented to green, pubescence scant to abundant; corolla medium size, 30-32 mm (1·18 inches) diameter, colour a light lilac (corresponding to Ridgway's[5] mauvette); anthers orange yellow, pollen medium to abundant, good quality; style straight; stigma globose, multilobed, green.

Katahdin

Tubers short elliptical to roundish, medium thick, mean length, 82·05±0·20 mm (3·23 inches)[6]; mean width 80·09±0·17 mm (3·16 inches),[6] mean thickness 60·53±0·20 mm (2·38 inches)[6]; indexes, width to length 97·80±0·32,[7] thickness to width 75·74±0·30,[8] thickness to length 73·90±0·32[8]; skin smooth, self-coloured, dark cream buff[9]; eyes shallow, same colour as skin; eyebrows medium long, curved, medium prominent; flesh white; sprouts, colour when developed in the dark, pale vinaceous lilac (Ridgway); maturity late.

[4] Calculated by dividing the width by the length of each of 100 leaflets and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of the stem, one leaflet, the distal left lateral, being taken from each leaf. Since the potato leaflet is asymmetrical, the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described in the following work: Salaman, R. N., Potato Varieties, pp. 163-170, Cambridge, 1926.

[5] Ridgway, R. Color Standards and Color Nomenclature, 43 pp., illus. Washington, D.C., 1912.

[6] The average of measurements of 100 tubers, each of a weight of approximately 8 ounces (223-233 g).

[7] Calculated by dividing the width of each 100 tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the indexes were taken from the same measurements as those used to designate the dimensions of the tubers.

[8] Based on measurements of the same tubers as those used for determining the width to length index, using the same methods of calculation.

[9] Between Ridgway's chamois and cream buff; classed as a white potato by the commercial trade.

Characteristics

The Katahdin potato has been under observation and test at Presque Isle, Maine, for a period of 12 years, during which time it has been highly resistant to mild mosaic, as shown by the fact that not a plant has been found infected with this disease in the field. Is is not, however, resistant to spindle tuber or leaf roll.

Like all varieties of potatoes, the Katahdin varies somewhat in cooking quality, according to the environmental conditions under which it is grown. Cooking tests, however, show that tubers of high quality are produced when this variety is grown under favourable conditions. The results of cooking tests made in co-operation with the Bureau of Home Economics of the United States Department of Agriculture at different times have shown the quality of the stock grown at Aroostook Farm, Presque Isle, Maine, to range from fair to very good, with good as the average, these terms being used to designate the three highest classes for quality in a scale of five. Reports from co-operators in other sections of the country show that the Katahdin compares favourably in cooking quality with standard varieties when grown under the same conditions.

CHIPPEWA

Description

Plants medium to large, spreading; stems thick, prominently angled; nodes slightly swollen, green; internodes slightly reddish purple; wings slightly waved or straight, green; stipules medium large, green, glabrous; leaves long, broad, midrib green, pubescent; primary leaflets close, green, four pairs, large, ovate, mean length 84.65±0.43 mm (3.33 inches), mean width 47.46±0.27 mm (1.87 inches), index 56.27±0.18[10]; petioles green; secondary leaflets medium in number, on midrib between pairs of primary leaflets; tertiary leaflets none; inflorescence medium in branching; leafy bracts medium in number to none; peduncles short to medium, pubescence scant; pedicels medium in length, little pigmented, pubescence scant.

Flowers.—Calyx lobe tips long, little pigmented to green, pubescence scant; corolla medium in size, colour a light lilac (Ridgway's mauvette) with white tips; anthers pale orange yellow, pollen scant, poor; style straight, stigma globose, green.

Tubers elliptical to oblong, medium thick, mean length 89.05±0.28 m. (3.51 inches),[11] mean width 78.77±0.22 mm (3.10 inches), mean thickness 57.27±0.16 mm (2.26 inches); indexes, width to length 88.73±0.45,[12] thickness to width 72.84±0.30,[13] thickness to length 64.52±0.34[13]; skin smooth, self-coloured, dark creamy buff[14]; eyes shallow, same colour as skin; eyebrows medium long, curved, medium prominent; flesh white; sprouts, colour when developed in the dark, creamy white with tips of scales a very dilute tint of pale rose purple (Ridgway); maturity medium late, about midway between Irish Cobbler and Green Mountain.

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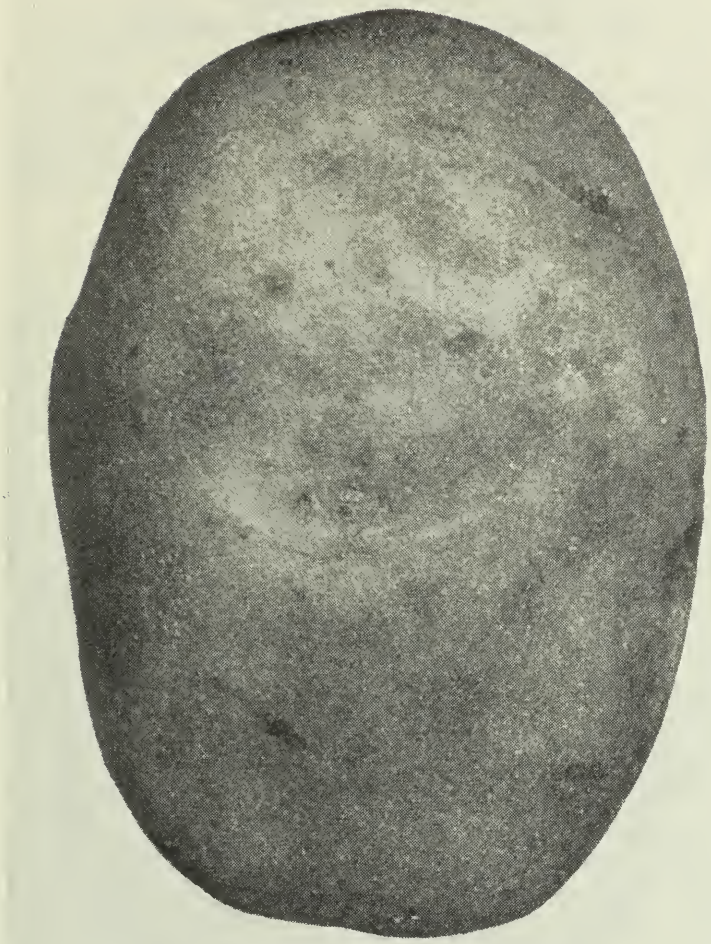
[10] See footnote 4.
[11] See footnote 6.
[12] See footnote 7.
[13] See footnote 8.
[14] See footnote 9.



Chippewa

Characteristics

The Chippewa potato has shown a high degree of resistance to mild mosaic.

GOLDEN

Description

Plants large, spreading; stems medium thick, prominently angled; nodes slightly swollen, slightly reddish purple; internodes slightly reddish purple; wings straight, green; stipules medium size, green, with scant, very fine pubescence on under side; leaves medium in length and width; midrib green; sparsely pubescent; primary leaflets green, five pairs, ovate, medium size, mean length 64.29±0.30 mm (2.53 inches), mean width 36.23±0.19 mm (1.43 inches), index 56.56±0.17[15]; petioles green; secondary leaflets many, 3 positions—on midrib between pair of primary leaflets, at junction of midrib and petioles of primary leaflets, on primary leaflet petioles; tertiary leaflets medium in number; inflorescence little branched; leafy bracts none; peduncles short, green, sparsely pubescent; pedicels short, green, sparsely pubescent.

Flowers.—Calyx lobe tips medium in length, green, sparsely pubescent; corolla medium in size, white; anthers lemon yellow to greenish yellow, pollen scant, poor; style straight, stigma globose, multilobed, green.

Tubers of medium size, roundish, mean length 85.36±0.35 mm (3.36 inches),[16] mean width 74.23±0.24 mm (2.92 inches), mean thickness

[15] See footnote 4.
[16] See footnote 6.

60.71±0.23 mm (2.39 inches); indexes, width to length 87.56±0.52,[17] thickness to width 81.99±0.41,[18] thickness to length 71.62±0.48[18]; skin smooth, self-coloured, dark cream buff;[19] eyes medium shallow, same colour as skin except the central eye in the apical bud cluster, which is a pale rose purple (Ridgway); eyebrows medium long, curved, medium prominent; flesh pale yellow (Ridgway's Naples yellow); sprouts, colour when developed in dark, white with tips of scales frequently showing trace of very dilute tint of rose purple (Ridgway); maturity late.

Golden

Characteristics

The Golden potato produces tubers of dark cream buff colour, smooth, with medium shallow eyes.

CULTIVATION

Like all other inter-tilled crops, the potato responds to careful and thorough cultivation. The use of the light harrow or weeder twice after planting, but before the young potato plants come through the ground, for the purpose of levelling the ground and destroying small weeds will save a lot of cultivation later and help to conserve moisture. Tillage may be overdone, but more frequently is too inefficiently as well as insufficiently done to be of greatest value to the crop. Weed control and conservation of moisture are the two primary functions of tillage. Of the two, weed control is the most important, since weeds use up the soil moisture and plant food. By the control of the weeds a soil mulch is maintained that also aids in soil moisture conservation. The early season cultivation is probably the most beneficial, since the tilth of the soil is improved

[17] See footnote 7.
[18] See footnote 8.
[19] See footnote 9.

and the soil moisture supply necessary to the young plants maintained. Deep and frequent tillage is important in the early part of the season, gradually becoming shallower as the plants become larger and shade the soil. The shading of the soil by the leaves tends to reduce the rate of evaporation of moisture from the soil. Deep cultivation at this stage of plant growth would injure the surface feeder roots. Tillage given late in the season, or after the tubers have formed, may be injurious to the crop. Therefore, the time that cultivation is given is more important that the frequency or depth.

RIDGING

The practice of ridging the potatoes up after the last cultivation is followed by a large proportion of growers. Ridging tends to provide drainage and, during cool seasons, helps to warm up the land. In sections where lack of moisture occurs in the mid-season, severe ridging may be of doubtful value, except for the fact that it provides friable loose soil in which the tubers can form. The crop may be dug with greater ease where ridging has been done.

The ridging of the crop may be quickly and very efficiently done by means of the lister double mouldboard plough, or the implement known as a horse-hoe. The latter mentioned implement can be got with scraper mouldboards or with revolving disks. These implements gather the soil up on both sides of a row and can be adjusted for different depths of ridging.

TILLAGE MACHINERY

Several types of cultivators are used. The single-row cultivator, with an adjustment lever to regulate the width and another lever attached to a wheel at the front, and a shoe at the back to regulate the depth that the teeth may enter the ground, has been in use for many years. This type is quite satisfactory where a small acreage has to be handled. When equipped with the harrow teeth irons, a very satisfactory job can be done. With the wing feet attached to the rear ends of the bars of this implement the soil can be moulded up to the potato plants. Some growers prefer to use the long wings that extend from the front to the back of the cultivator.

The spring tooth single-row cultivator is also very useful.

The two-row cultivator, built on wheels and provided with a seat for the operator to ride on, is one of the most efficient machines to use where a large acreage is grown.

SPRAYER

Since the yields per acre can be severely impaired if insects and diseases are not kept under control it is important that a power sprayer be used for applying the combined insecticide and fungicide. A four-row sprayer equipped with three nozzles for each row and capable of maintaining from 200 to 300 pounds pressure per square inch, will give the most satisfactory results. In the last two chapters of this bulletin, control measures for insects and diseases are discussed.

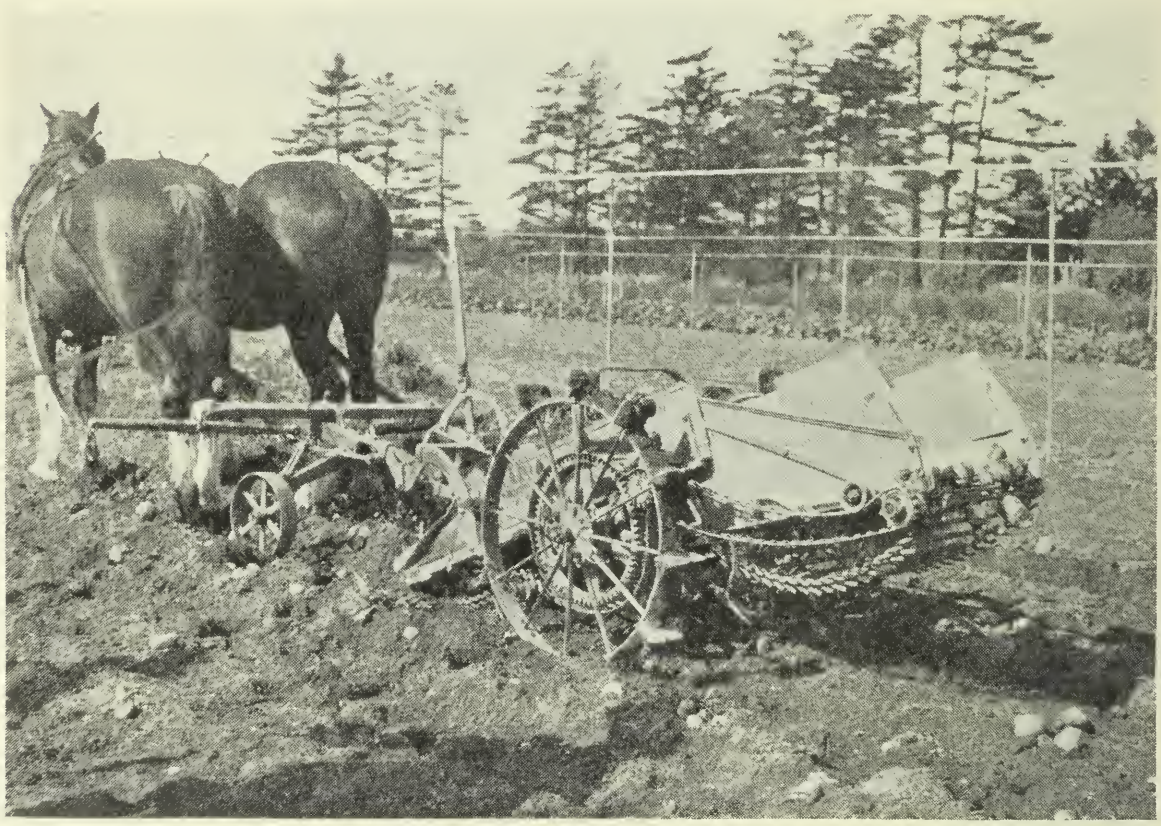
HARVESTING

Where the soil is well drained and conditions are fairly ideal for the crop, digging can be deferred until late in the autumn, but where the land is on the heavy side and inclined to be wet, digging should be done before the autumn rains set in. It has been found, where the crop has been free from blight, that the digging can be done to advantage during late September or early October. At any rate, digging should be done before the ground freezes during the nights.

If late blight has been present, digging had better be deferred until the latest possible date. The tubers that are diseased can then be easily detected and left in the field. Early digging of a diseased crop and piling in the field or placing in a storage cellar encourages the spread of the disease to other healthy tubers. See recommendations on control of foliage diseases, page 66.

DIGGERS

A number of very efficient makes of potato diggers are now on the market. These machines vary in principle from the plough type, with steel prongs at the back to raise the tubers out of the ground, to the rotating sprocket two-prong type and the endless chain elevator type. More recently, power-driven diggers with bagger attachments have made their appearance.



Digger, endless chain elevator type.

Mechanical diggers have to be operated with discretion to prevent unnecessary injury to the tubers. The rods of the apron shaker at the rear of the digger should be padded with pieces of old rubber hose to lessen bruising.

The potato, like all other vegetable crops, should be handled carefully so as to avoid mechanical injury.

Digging by means of a four-tined fork is still done where a small area is to be handled. One good man can dig about a half an acre in a day, while a mechanical digger can lift from three to five acres in a day.

Ploughing out with a single mouldboard plough with the coulter removed is still employed by some farmers. By means of four-tined potato digging grapes, made in a hoe-like shape, the tubers are removed from the loosened ground.

Where diggers are used, the usual practice is to dig every second row so as to avoid damaging the tubers already on the surface of the ground. After the tubers already dug are picked up the remaining rows are dug.

Some growers follow the practice of using the spring-tooth harrow on the land directly after the digging is done, to drag out tubers that have remained slightly covered in the soil.

Digger, revolving rear wheel type.

STORING POTATOES

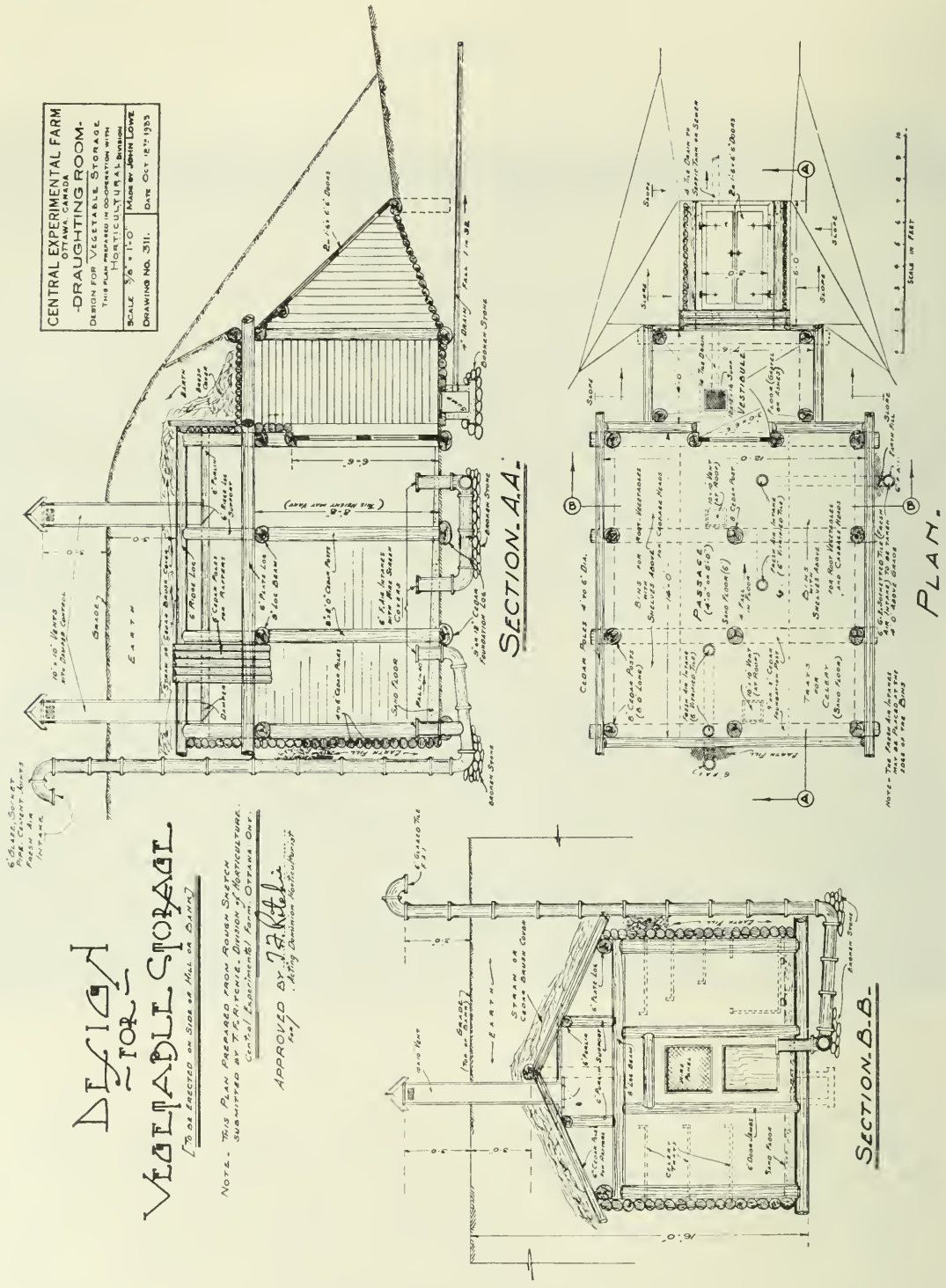
When going into storage, the tubers should be as dry as possible. All diseased or damaged tubers should be sorted out. The best storage temperature for seed stock is 33° to 38° F., but for table use 38° to 42° F. will give best results. Lower temperatures tend to cause a sweet flavour. Storing potatoes in the basement of a dwelling house is not, as a rule, satisfactory owing to the difficulty of providing proper ventilation. Many thousands of bushels of potatoes are lost each year through storing in faulty cellars, closely constructed bins and where the temperature is too high.

For sections where very severe conditions are experienced during winter, a storage cellar built entirely in the ground and provided with intake and outlet ventilation will be found very satisfactory. An ideal location for this type of storage cellar is in a hill side where good drainage can be had. Where cedar poles, posts and logs are available, such a cellar can be built quite cheaply. On the other hand, if these materials are not available a more durable concrete construction would possibly be more satisfactory. The potatoes will keep much better when placed in slatted bins. A false floor and walls made of boards six inches wide, with half-inch cracks between, will allow air circulation. The false floor and false walls should be six inches from the floor and walls of the cellar. A cellar, 14 feet wide and 30 feet long, provided with bins as described, should take care of 1,000 bushels.

Towards spring, when the air is warm, it may be necessary to open the ventilators and doors at night, when the air is cool, and to close them again in the morning. By this means the potatoes can be kept dormant for a much longer period.

Temporary pitting in the field at digging time is sometimes done. Fifty to sixty bushels are piled up and covered with straw and earth. Should the weather become colder more earth should be applied as a covering for the pile. Dis-

eased potatoes, when dug late, should be placed on the barn floor in a shallow flat pile and, if necessary, covered with hay or straw to protect them from frost. All light must be excluded, as potatoes deteriorate in quality very rapidly when exposed to it.



PITTING OUT-OF-DOORS

When storage cellar space is not available, a temporary pit may be made that will be very satisfactory. Select a well drained location. To store 500 bushels of potatoes, dig a trench 4 feet deep, 14 feet wide and 15 feet long. Line the sides with boards or small poles to keep the earth from falling in. Fill in about $3\frac{1}{2}$ feet of potatoes. Then logs are placed around the sides to serve as a wall plate and to keep the soil from caving in. To support the covering, a strong log is placed lengthwise down the centre. Small poles, $7\frac{1}{2}$ to 8 feet long,

are placed with one end resting on the central log and the other end on the logs at the edges of the pit. The whole roof of the pit is covered on both sides in this way. Two ventilators made of lumber 6 by 6 inches square and 4 feet long, are placed one at each end of the pit. The roof poles are then covered with a foot or so of straw to prevent the soil from falling through. Sods are placed over this and some soil spread over the sod to make about one foot of soil covering. Rotted, dry horse manure, to the depth of one foot, is placed over the soil.

The space between the roof of the pit and the potatoes is not filled with straw. A thermometer is lowered, by means of a string, into the pit through one of the ventilators. The temperature should remain at 40°F. During cold weather, the ventilators may have to be plugged with burlap bags.

GRADING

The free use of the mechanical grader to produce a uniform product for market is recommended. These machines can be made to grade in accordance with the regulations laid down in the Fruit, Vegetables and Honey Act. For those with only a small crop to handle, a hand power machine is quite satisfactory, but where a very large quantity is to be graded, a power driven grader will prove a great advantage.

Growers should make the practice of using new sacks with their name stencilled on them.

The most commonly used type of commercial package is the burlap bag. This type of a container is the most satisfactory to use. There is less danger of the potatoes being damaged by handling, when put up in the burlap bags.

Potato grading by hand power machine.

The new weights which are now legal standards for table potatoes packed in cotton, jute, or mesh bags for sale are 100 pounds; 75 pounds; 50 pounds; 25 pounds; and 15 pounds. The weights for potatoes pre-packed in paper bags are 10 pounds and 15 pounds.

Where special trade is being catered to, such as for baking potatoes, the selected tubers may be put up in attractive containers which may take the form of special cartons or small bags.

The Fruit, Vegetables and Honey Act should be complied with, when preparing potatoes for market. Copies may be obtained from the Publicity and Extension Division, Dominion Department of Agriculture, Ottawa, Ontario.

COST OF PRODUCTION

There is a great deal of difference in the cost of producing potatoes in different parts of Canada. Various factors have to be considered. Cost of labour varies in different sections, as does the cost of insect and disease control. Then there is the cost of fertilizers, and the question whether the total amount of fertilizer should be charged up to the potato crop or divided between the other crops in the rotation. The cost of production, worked out by the Division of Field Husbandry for Eastern Canada during the eight-year period from 1923 to 1930, is given in table 6.

TABLE 6—AVERAGE COST PER ACRE OF PRODUCING POTATOES ON DOMINION EXPERIMENTAL FARMS IN EASTERN CANADA, 1923-1930

Items		*Ottawa, Ont.	Charlottetown, P.E.I.	†Fredericton, N.B.	Average of all farms
Use of land	$	7 50	3 00	3 00	4 50
Share of manure	$	9 32	13 19	9 24	10 58
Share of fertilizer	$	2 01	1 07	1 15	1 41
Seed (farm price—50 per cent)	$	17 82	16 08	16 32	16 74
Machinery	$	2 85	2 85	2 85	2 85
Spray materials	$	6 38	3 52	8 14	6 01
Manual labour at 22 cents per hour	$	32 16	19 36	20 02	23 85
Horse labour at 10 cents per hour	$	9 35	8 74	8 96	9 02
Total cost per acre	$	87 39	67 81	69 68	74 96
Yield per acre	bush.	231·2	287·7	254·4	257·8
Value per acre	$	152 59	189 88	167 90	170 12
Cost per bushel	$	0 38	0 24	0 27	0 29

* 7-year average. † 6-year average.

With an average yield of 257·8 bushels, the total cost of producing potatoes has been $74.96 per acre, or 29 cents per bushel.

To produce an acre of potatoes has required 108·4 hours of manual labour and 90·2 hours of horse labour. In addition, 90 hours of manual labour and 37·7 hours of horse labour have been required to grade and market this crop.

In estimating the cost of marketing potatoes, grading and bagging have been calculated at 6 cents per bushel. One man and a team hauling 140 bushels per day will add a haulage charge of 3 cents per bushel. Bags have been priced at 7 cents each. On this basis the total cost of grading, bagging and hauling to market would amount to 13·7 cents per bushel, or, with a yield of 257·8 bushels, $35.32 per acre.

The yield given above includes the unmarketable potatoes. At the Fredericton Station, where the yields of marketable and unmarketable potatoes have been recorded separately, the total yield of 254·4 bushels per acre has included 29·5 bushels of unmarketable potatoes, or 11·45 per cent of the total.

INSECTS ATTACKING THE POTATO

BY

ALAN G. DUSTAN

Division of Entomology, Science Service

The potato is frequently attacked by insects of one species or another. Although the foliage is most frequently injured, damage to the stems and tubers is not at all uncommon. Fortunately, most of the insects attacking the leaves and stems of the plants can be easily controlled if remedial measures are taken early. But, as is true in the case of all injurious forms, the best results can be expected only if insecticides are applied as soon as the insects appear.

In planning control operations it should be borne in mind that insects, according to the manner in which they feed, may be divided roughly into two classes, namely, biting or chewing insects, and sucking insects. The former, in feeding, actually chew pieces out of the leaves and can, therefore, be killed by coating the surface of the foliage with a stomach poison such as lead arsenate. The latter class, on the other hand, suck the juices from the plant by means of a sucking tube inserted into the tissues. They must be controlled by a contact poison, as, for instance, nicotine sulphate, which kills the insects when it comes into contact with their bodies. Stomach poisons have no controlling effect on sucking insects.

To assist the grower in identifying the insects attacking his potato vines, the following key has been prepared. A key to insects commonly found feeding on the tubers precedes the section dealing with such species (page 60).

IDENTIFICATION KEY TO INSECTS ATTACKING POTATO FOLIAGE

I. Large insects, at least $\frac{1}{4}$ of an inch in length:

(*a*) Insects with hard bodies, having the wing covers marked with yellow and black stripes.

Colorado Potato Beetle

(*b*) Insects with comparatively hard bodies, uniformly grey, purplish or black.

Blister Beetles

(*c*) Insects with softer bodies, greenish-yellow with four black stripes on the thorax and outer wings.

Four-lined Plant Bug

(*d*) Grubs with very soft bodies, brick red, with black markings, quite small when young.

Colorado Potato Beetle Larvæ

II. Small insects, much less than $\frac{1}{4}$ of an inch in length:

(*a*) Dark blue to black, jumping actively when disturbed.

Potato Flea Beetle

(*b*) Pale green, active, more or less solitary.

Potato Leafhopper

(*c*) Pale to dark green, moving very slowly when disturbed, feeding in clusters.

Potato Aphids

(*d*) Grubs with very soft bodies, brick red, with black markings.

Colorado Potato Beetle Larvæ

INSECTS ATTACKING THE FOLIAGE

The Colorado Potato Beetle*

The Colorado potato beetle is sufficiently well known to most growers to need little introduction. The adult is a hard-shelled beetle, about $\frac{3}{8}$ of an inch in length, having the wing covers ornamented with yellow and black stripes. It winters in the soil, and in the spring, often before the new crop of potato plants is up, may be seen wandering over the soil waiting for its favourite food plant to appear. The eggs are laid on the undersides of the potato leaves, and the young, as soon as they hatch, attack the foliage; both adults and larvæ are destructive, but the latter do more damage than the beetles. Tomato, eggplant, tobacco, and nightshade are also attacked. The Colorado potato beetle is found in every province of the Dominion.

The Colorado potato beetle; hair line indicates natural size (after Gibson).

CONTROL

Eastern Canada.—This insect can be easily and satisfactorily controlled by spraying or dusting the vines with an arsenical. Since potatoes are frequently attacked by fungous diseases it is customary to dilute the poisons in Bordeaux mixture rather than water, in this way controlling both insects and diseases in the one operation. Spraying is perhaps the most generally accepted method of applying the insecticide when fighting this insect, although dusting is almost as effective. Control measures should be undertaken as soon as the first eggs hatch; the operation should not be delayed until the plants commence to show signs of injury. Make the first application early and repeat when necessary. Treatments are usually made at intervals of 10 days to 2 weeks, depending on weather conditions and the seriousness of the attack, and 5 or 6 applications during the season are commonly given. Spray or dust thoroughly, covering the upper and lower surfaces of the leaves. If spraying, use 100 to 120 gallons of spray per acre at each application in the case of fully grown plants and proportionately less where full growth has not been attained. At least 50 pounds of dust per acre should be used where dusting is practised.

When spraying, use either 2 pounds of lead arsenate, $1\frac{1}{2}$ pounds of calcium arsenate or $\frac{3}{4}$ of a pound of paris green to 40 gallons of 4-4-40 Bordeaux mixture. Directions for making Bordeaux mixture will be found on page 65. If the arsenicals are diluted in water instead of Bordeaux, 2 or 3 pounds of hydrated lime should be added when paris green or calcium arsenate is used, since this prevents any possibility of burning.

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* Leptinotarsa decemlineata Say.

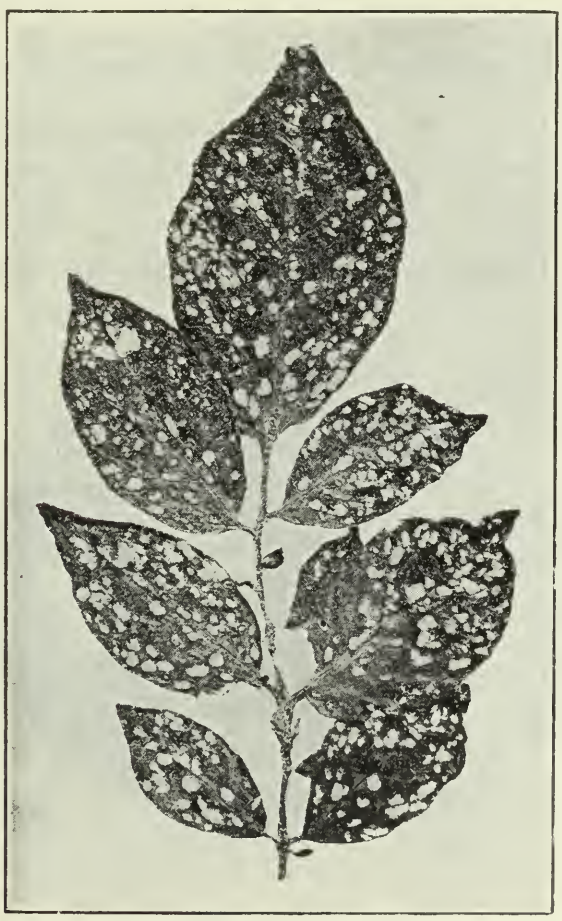
The best dust to use is one composed of 12 pounds of dehydrated copper sulphate, 8 pounds of calcium arsenate and 80 pounds of hydrated lime. This dust has a fungicidal value as well as being a good insecticide. If fungous diseases are not a factor of importance a dust made up of 8 pounds of calcium arsenate and 92 pounds of hydrated lime will give good results against the potato beetle.

Prairie Provinces.—On the prairies, a dust composed of 1 part of calcium arsenate or paris green to 10 parts of hydrated lime is recommended. In areas where there is no dew, white arsenic can be substituted for calcium arsenate and used at the same strength. In Alberta, arsenate of zinc has given excellent control when diluted with hydrated lime or flour, at the rate of 1 to 10. Sprays of calcium arsenate or paris green diluted in water as recommended for Eastern Canada can also be used with good results.

British Columbia.—Spray or dust with any of the arsenicals as advised for Eastern Canada.

The Potato Flea Beetle*

The potato flea beetle, a tiny insect which commonly passes unnoticed, frequently causes severe injury to the foliage of potatoes by eating small round holes through the leaves. In severe cases of infestation the holes become sufficiently numerous to cause browning and death of the foliage. The beetle



Typical injury to potato foliage by the potato flea beetle (after Gibson).

itself is only about $\frac{1}{16}$ of an inch in length and is black with brown legs. It is able to jump very actively and, due to this habit, is elusive and difficult to see. The adults feed readily on a wide range of vegetables and weeds, the larvæ living in the soil where they attack the roots. In the case of the potato, the

* *Epitrix cucumeris* Harr.

tubers are sometimes attacked, resulting in the formation of small, brownish, corky areas. In some instances these are flat or slightly sunken, in other cases definite depressions or tunnels into the flesh are formed while, less frequently, tiny pimples are produced. The faintly brown, corky tissue is evident, however, under all circumstances. If these areas are cut through, it will be found that usually this corky tissue is projected into the flesh in the form of a fine sliver-like structure.

Potato injured by the feeding of potato flea beetle larvæ (author's illustration).

A more definite "pimply" condition is sometimes noticed in which the surface of the potato becomes covered with low, wart-like pimples. This is caused by some other agency which is, as yet, unknown. Quite severe epidemics of this "pimply" condition are noticed in certain years and growers are asked to co-operate with the Department of Agriculture by sending in samples for examination and study.

"Pimply potato", caused by some unknown agency (author's illustration)

CONTROL

Eastern Canada.—These insects are easily controlled by spraying the foliage with 4-4-40 Bordeaux mixture as described on page 65 to which has been added 2 pounds of calcium arsenate. Make the first application as soon as the insects are seen and repeat in 10 to 12 days, or when necessary.

Prairie Provinces.—Treat the plants when the injury first becomes apparent, with a dust composed as follows:—

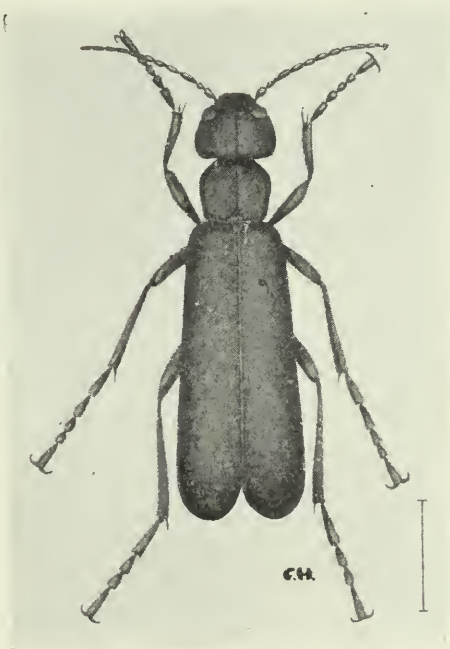
Paris green	1 part
Copper carbonate	1 part
Hydrated lime	4 parts

Repeat the application as soon as the work of the beetles is again noticed.

British Columbia.—Spraying with Bordeaux mixture alone acts as a deterrent. Paris green or lead arsenate may be added to the Bordeaux to make it more effective, or these may be used alone; 1 pound of lead arsenate or $\frac{1}{2}$ pound of paris green and 4 ounces of casein should be used to each 40 gallons of water. In the latter case, $\frac{1}{2}$ pound of freshly slaked lime should be added. Lead arsenate or paris green may also be used dry and should be mixed with hydrated lime at the rate of 1 pound of the poison to 20 pounds of hydrated lime, and the dust applied in the early morning when the plants are wet with dew. In the case of tomato plants, protection may be secured by the same treatment or by dipping the whole plant except the roots, before planting, in a mixture of 1 pound of lead arsenate in 10 gallons of water.

Blister Beetles

These beetles, sometimes referred to as "old fashioned potato-bugs," because they were responsible for most of the injury to potato vines prior to the invasion of the Colorado potato beetle, are occasionally found in swarms in potato fields. They have the habit of appearing suddenly and, after feeding for a short time, disappearing with equal abruptness. The injury caused by these beetles closely



The black blister beetle; hair line indicates natural size (after Gibson).

resembles that of the Colorado potato beetle, but unlike that species, only the adults are destructive, the first stage larvæ living in the ground where they feed on grasshopper eggs. The adults are fairly large, about $\frac{5}{8}$ of an inch in length, soft-bodied and grey, black or purplish, in colour. They are found in every province of Canada.

CONTROL

Arsenical sprays and dusts are not effective against these insects. On the other hand, dusts composed of barium or sodium fluosilicate diluted with six parts of low grade flour (by volume) give satisfactory control.* An application of either of these poisons should be made when the beetles first appear and repeated applications made if and when necessary. As the insects are known to be attracted to sweet clover bloom, susceptible crops must be carefully watched about the time the clover blossoms dry up, since migration to other hosts frequently takes place then. A second application of poison may be necessary at that time.

In small gardens or field plots, spraying the beetles with one of the standard pyrethrum preparations is a very effective method of control. Directions for diluting this insecticide will be found on the container in which it is sold.

Barium and sodium fluosilicate are poisonous to human beings and live stock but pyrethrum extracts are quite harmless to both. This fact should be borne in mind when using the two first mentioned materials and the necessary precautions taken.

In Saskatchewan it has been found that a solution of epsom salts and water (three tablespoonfuls to one gallon) acts as a deterrent to Nuttall's blister beetle when sprayed on the foliage of plants on which these insects are feeding. Other species might be similarly affected and gardeners are advised to give the method a trial. This spray does not kill the beetles but appears to have a repellent action which drives them from the crops upon which they are feeding.

In Alberta, treating infested plants with a dust composed of one part of paris green, one part of derris (4 per cent rotenone) and 10 parts of hydrated lime, by volume, has given most satisfactory control of blister beetles. An effective spray for use against these insects in that province consists of two tablespoonfuls of paris green, one dessertspoonful of nicotine sulphate, or two ounces of derris (4 per cent rotenone), to two gallons of water. This has been used with success on potatoes, caragana, honeysuckle and sugar beets. In spraying caragana some spotting of the leaves has been noticed where the material was applied in bright sunlight. Such injury can, of course, be avoided by applying the spray in the evening or during periods of dull weather.

The Potato Leafhopper†

The potato leafhopper is a small, green, very active insect found commonly on the under surfaces of potato leaves. It feeds by sucking the juices out of the foliage, causing it to change in colour from dark to pale green and, in severe infestations, to yellow. Frequently the margin and tips of leaves attacked by these insects turn brown and in cases where the insects are very abundant defoliation takes place. The larvæ resemble the adults in colour and shape but are wingless and, except when fully grown, are considerably smaller in size. Although present in all provinces of Canada the potato leafhopper is a pest of importance only in the East.

CONTROL

Use 4-4-40 Bordeaux as advised for flea beetles on page 52. Spray particularly the under sides of the leaves, making the first application when the leafhoppers commence to attack the plants. Repeated spraying should be given at 10-day intervals as needed.

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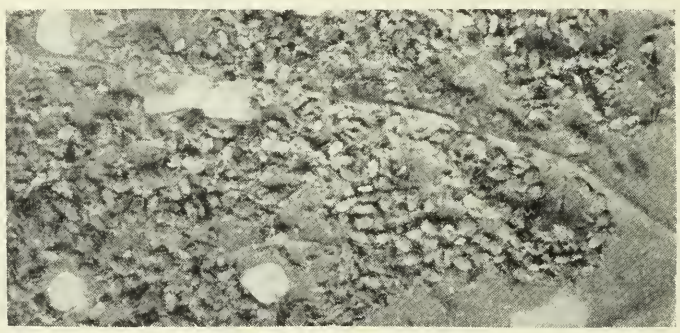
* K. E. Stewart, Forest Insect Investigations, Ottawa.
† *Empoasca fabae* Harr.

The potato leaf hopper; (1) adults; (2) nymphs; (3) potato vines destroyed; treated plot in background (author's illustration).

The Potato Aphid*

This insect is not present in injurious numbers annually, but sudden outbreaks appear at irregular intervals when weather conditions are suitable. The potato aphid is a sucking insect, clustering in immense numbers on the undersides of the leaves and on the young shoots, where it causes a distinct yellowing of the foliage. In severe infestations the leaves turn brown and die. The insect is pale green in colour. It is normally found in clusters or groups and is extremely sluggish, moving slowly even when actually disturbed. In years of abundance it can cause very serious losses and should be watched for carefully.



Typical aphid colony, feeding on underside of leaf (author's illustration).

CONTROL

Dust the vines with a 2 per cent nicotine dust when the first aphids are seen, using a cotton trailer behind the duster. Directions for the preparation of this material are given on page 64. Pay particular attention to the undersides of the leaves as the aphids are found there chiefly. Spraying with nicotine sulphate at the rate of $\frac{3}{8}$ of a pint to 40 gallons of water, to which is added 2 pounds of laundry soap, will give fair control but is not as satisfactory as dusting. A second or third application at intervals of a week to 10 days may be necessary if the infestation is heavy.

The Four-Lined Plant Bug**

In New Brunswick, this insect is frequently a pest of importance in garden plots or small potato fields. The winter is passed in the egg stage, the eggs being commonly laid in weeds and other plants growing on the margins of fields. As a result, when hatching takes place in the spring, potatoes growing at the edge of a field are more heavily attacked than those situated in a more central position. This is particularly true in the early part of the season when most of the insects are wingless and migration of necessity slow. After wings are developed the plant bugs spread more evenly over the field and injury then becomes less noticeable. In feeding, the insects pierce the leaves and suck out the juices. A black spot develops at each puncture and when the infestation is severe, entire leaves turn black and the plants become stunted and unthrifty. The four-lined plant bug is a pest of economic importance only in Eastern Canada.

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*_Illinoia solanifolii_ Ashm.
**_Poecilocapsus lineatus_ Fab.

The four-lined plant bug, enlarged and natural size (author's illustration).

Dusting with a 5 per cent nicotine dust has given the best control against this insect. The material should be applied when the injury first becomes apparent, which will be while the majority of the bugs are still wingless. Concentrate on the margins of the field and arrange to apply the dust on a warm, calm day. Directions for the preparation of nicotine dusts will be found on page 64.

INSECTS ATTACKING THE STEM

The Potato Stem Borer*

Primarily a pest of the small, backyard, potato patch, this insect seldom, if ever, causes any damage in commercial potato fields. The borer, which when full grown is about $1\frac{3}{4}$ inches long, pinkish-white in colour and with a brown head, has the unfortunate habit of migrating from stem to stem, thereby greatly increasing its powers of destruction. Attacked plants quickly wilt and eventu-

Work of the potato stem borer (author's illustration).

ally die. The moth of the potato stem borer lays its eggs in late August on weeds and grasses growing in the vicinity of such favoured host plants as potato, corn, rhubarb, etc. These eggs hatch in June of the following year, when the young borers seek out some fleshy-stemmed weed or cultivated plant, entering near the ground and tunnelling up the stem. This insect is a pest of importance only in Eastern Canada.

**Hydroecia micacea* Esp.

CONTROL

(1) Destroy all weeds during the latter part of August and September, when the moths are laying their eggs. This applies, not only to weeds growing in the garden, but also to those present in surrounding wasteland.

(2) Practise crop rotation, following susceptible crops by others less frequently attacked, such as turnips, cabbages, etc.

(3) Pull and destroy plants as soon as injury is noticed, since this prevents the insects from migrating from host to host and multiplying the amount of injury.

Cutworms

Although not looked upon as a serious pest of the potato, cutworms occasionally cause considerable injury in individual fields. The damage is done chiefly in the early part of the season when the plants are coming up, the cutworms hiding in the soil at the base of the vines and nipping off the young shoots as they break through the ground. The black cutworm (*Agrotis ypsilon* Rott.) sometimes appears later in the season, when it attacks the partially grown plants. However, these insects are not a regularly recurring pest in potato fields and only in exceptional cases are potato growers forced to take special remedial measures.

Potato vine cut down by the black cutworm (author's illustration).

CONTROL

Should cutworms be present in sufficiently large numbers to threaten the crop, the use of poisoned bran bait as mentioned on page 65 is recommended. If the plants are small, the bait should be broadcast over the field at the rate of 20 pounds to the acre. In fields where the vines are larger and sufficient foliage has developed to catch and hold the bran, the bait should either be placed around each plant or scattered along the rows. As cutworms feed at night, the bait should be distributed in the late evening of a warm day. Do not put it out at any other time, since it will be dry and unpalatable before the insects come up at sundown to feed, and if the evening is cold delay the application until weather conditions are more suitable. Two or three applications, at intervals of three days, may be necessary to control the cutworms.

IDENTIFICATION KEY TO INSECTS AND SLUGS ATTACKING THE TUBERS

I. Tubers showing distinct holes or feeding scars due to the work of insects:—

(*a*) Tubers with small round holes which connect with tunnels running through the flesh. The tissue surrounding the tunnels is frequently discoloured and in severe infestations rotted areas are commonly found.....*Wireworms*

(*b*) Tubers with large, open, shallow or deep excavations into the tuber, the exposed tissue showing the feeding scars of the insects which resemble the teeth marks of mice and in many cases become wholly or partially healed over. Margins of excavations more or less even and regular, seldom ragged. Discoloration and rotting of flesh rare.....*White Grubs*

(*c*) Tubers with smaller but relatively deeper excavations, having the the edges surrounding the entrance holes ragged. Large chambers are eaten into the flesh and frequently the skin persist even though the underlying tissue has been entirely removed. Slime usually present with discoloration and rotting of tissue common in storage .....*Slugs*

II. Tubers without visible feeding scars but with minute, brownish, corky areas on the skin. These may be flat, slightly sunken or actually produced into definite depressions or very small tunnels, running into the flesh. Occasionally these areas take the form of tiny pimples.....
Potato Flea Beetle (larvæ)

INSECTS ATTACKING THE TUBERS

Wireworms

As wireworms are found naturally in sod and grassland, potatoes, planted on freshly reclaimed ground are frequently attacked by these insects. They enter by way of the skin and in feeding make numerous tunnels through the tubers. The tunnels are about $\frac{1}{8}$ of an inch in width and are usually sur-

Potato damaged by wireworms
(after Gibson and Twinn).

rounded by darkened tissue. If the tubers are heavily infested, the flesh breaks down and rotting quickly sets in, which renders the potato unfit for market purposes. Heavy, damp soils are usually more severely infested than sandy, well-drained land.

Wireworms are the young of click beetles which lay their eggs, preferably, in sod. The larvæ, or wireworms, live in the ground throughout their life, feeding on the roots of grasses. They take at least three years to mature. These insects attack a wide range of wild and cultivated plants and are present in every province of Canada.

CONTROL

There is no specific control known for these insects, although growers may do much to lessen their destructiveness by proper farming methods, care in the selection of their land and in the choice of crops planted. Soil known to be infested with wireworms should be avoided and land free of this pest selected when choosing a spot in which to plant potatoes. Freshly broken sod should be carefully examined, since wireworms are frequently abundant in such situations. It is also well to remember that these insects prefer damp, poorly drained land. Encourage quick growth of plants, through proper tillage and the liberal use of fertilizers. On land known to be infested, grow such crops as buckwheat, flax, alfalfa, clover, beans, peas, field peas, rape, turnips, mangels, sunflowers and squash. Then, when the soil is freed of these insects, susceptible crops, such as potatoes, corn and strawberries may be substituted. When grain is planted on land in which wireworms are present, seed somewhat more heavily than normal to provide for loss of some plants. Short rotations will be found helpful and should be practised on all infested farms.

White Grubs

White grubs are the young of June beetles and, like wireworms, are always more numerous in freshly broken land. The mature grubs are about 1½ inches in length, greyish-white, with brown head and legs. When at rest they usually lie curled in a half circle. Among other plants, these insects commonly attack the potato, eating out small, wide-spreading excavations which usually have

Potato damaged by white grubs (author's illustration).

regular and even margins. Definite chambers or holes are found only in the case of severe infestations. The jaw marks of the grubs are easily discerned in the eaten-over area and resemble the teeth scars made by mice. Rotting of the tissue seldom follows the feeding of white grubs, although this is sometimes noticed when the tubers are lying in wet soil, but in most cases the exposed area heals over, forming a roughened scar.

The eggs of June beetles are laid preferably in sod and the resulting white grubs require three years in which to mature. During this time they live in the soil, where they feed on the roots of grasses and a wide range of other plants. The most destructive feeding takes place in the second year of their life. They are found in all the provinces of the Dominion but are of greatest economic importance in Quebec and Ontario.

CONTROL

The greatest care should be used in selecting a field in which to plant potatoes in districts where white grubs are prevalent. Fields with a grub population of three or more per square yard should be avoided where possible and only those fields chosen which are known to have a small number of these insects present. Clay or heavy clay loam soil standing in stubble or from which a hoed crop has just been removed is usually comparatively free of white grubs. Such soil should be fall-ploughed and thoroughly worked up in the spring before planting, as such practices assist in reducing the numbers of insects present.

Where it is not possible to select a piece of ground free from white grubs and where only heavily infested fields, such as old pasture or two-year-old meadow, are available, extra preparation of the soil becomes necessary. Plough in early September at a comparatively shallow depth, and follow with a thorough disking. In the spring, disk the ground 5 times before planting, or 4 times where a tractor is used. Such a cultural program should reduce the white grub population to a point where little injury to the tubers will result.

Sod land, which may be so situated as to become infested regularly with white grubs, can be protected from infestation. This can be brought about by scattering superfine sulphur, broadcast by hand or seed drill on the grass about May 24 at the rate of 300 pounds per acre. This practice should be of particular value where, for one reason or another, it is known a year in advance that a certain piece of sod, likely to be infested, will be desired for potatoes.

The treatment should be undertaken in the year of June beetle flight, and it will serve to protect the potatoes the following year when the grubs would be most destructive, by repelling the beetles when attempting to lay their eggs in the sod.

June beetles are only in flight in important numbers in most districts every third year. Their flight years are known for most parts of Canada so that if any difficulty is encountered in determining this in any locality, the information can be secured by applying to the Dominion Entomologist, Department of Agriculture, Ottawa.

Slugs

Potatoes growing on heavy land are sometimes attacked by slugs which not only feed on the foliage but also injure the tubers. When the tubers are attacked, the slugs eat their way through the skin and once inside clean out a cavity which, in some cases, may be almost as large as the potato itself. Frequently the skin remains intact, with the exception of the entrance hole, while in other cases it breaks away leaving a ragged, irregular opening fringed with fragments of skin. Traces of slime secreted by the slugs are usually found inside the tuber and, in storage particularly, rotting and blackening of the tissue frequently takes place.

While the vines remain green, the slugs confine their attack to stems and leaves of the plants, but as soon as the tops die down they turn their attention to the tubers, which are injured in the manner already described.

CONTROL

There is no specific remedy for slugs when feeding on tubers, but if the vines are kept thoroughly sprayed or dusted with Bordeaux mixture throughout the summer little trouble will be experienced from this pest. Dusting infested plants

with hydrated lime in the late evening will also kill many of the slugs. Since the slugs confine their attack to the foliage as long as it remains green, the shorter the time elapsing between the dying down of the tops and the removal of the tubers from the ground the better.

Potato damaged by garden slugs
(after Gibson and Twinn).

There has recently come on the market a new control for slugs, consisting of metaldehyde and bran. This material is set out in the field in small piles and has proved very effective in combating these animals. It can be secured at most seed houses and some hardware stores. The value of metaldehyde in gardens and small plots has been definitely established but its use under field conditions has not as yet been entirely proved. Experimental work bearing on this point is still in progress.

INSECTICIDES IN COMMON USE AGAINST INSECTS ATTACKING THE POTATO

Stomach Poisons—For Biting Insects

Lead Arsenate.—This is the most commonly used insecticide to-day, because it is absolutely safe to use on any foliage without fear of burning. Its chief disadvantages are that it kills insects rather slowly and is comparatively expensive. As a spray, it should be used at the rate of $1\frac{1}{2}$ to 2 pounds to 40 gallons of water, or Bordeaux mixture, and in dust form is customarily diluted with 6 to 8 times its weight of hydrated lime, or other carrier.

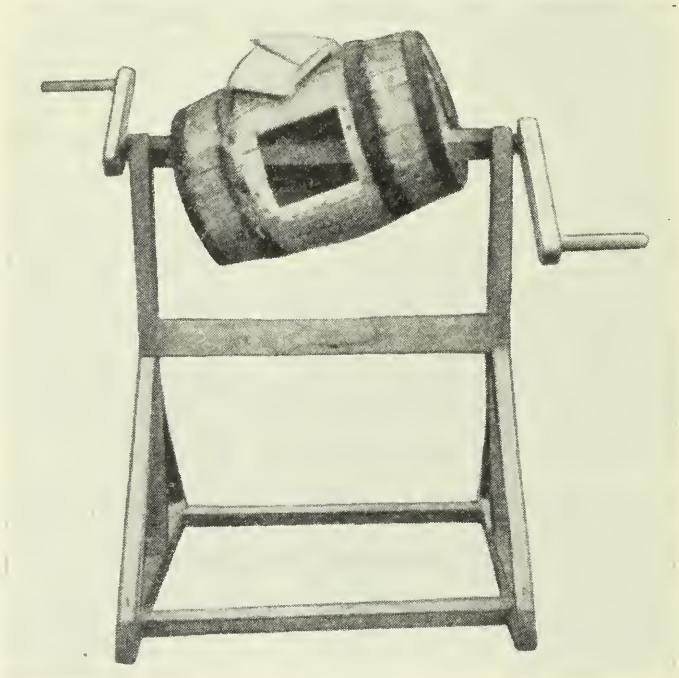
Calcium Arsenate.—This arsenical is coming into more general use on account of its cheapness and rapid killing properties. It is more likely to cause foliage burning than lead arsenate and for that reason, when used as a spray, a small amount of hydrated lime, about 2 pounds to 40 gallons, is usually added to neutralize the water-soluble arsenic present. Calcium arsenate $\frac{3}{4}$ to 1 pound to 40 gallons of water is the usual dosage for this arsenical, or 1 part of poison to 10 parts of hydrated lime, when used as a dust.

Paris Green.—Once a very popular poison, paris green is being replaced by the above-mentioned arsenicals due to its high cost, tendency to cause foliage injury, and because it is very difficult to hold in suspension when mixed with liquids. It is used in spray mixtures at the rate of $\frac{1}{2}$ to $\frac{3}{4}$ pound to 40 gallons of water, or Bordeaux mixture, and as a dust should be diluted with 15 to 20 parts of hydrated lime. When used as a spray with water, at least 2 pounds of hydrated lime should be added to each 40 gallons of solution.

Pyrethrum.—This insecticide consists of the ground up flowers of certain species of the genus *Chrysanthemum*. It is extremely toxic to many insects but quite harmless to human beings, which makes it very useful in the treatment of vegetables when nearing marketable size. Pyrethrum can be used either as a dust, diluted with talc, gypsum or ordinary wheat flour, or as a spray. There are many excellent pyrethrum sprays available on the market. In using these, the directions for mixing and applying as found on the container should be carefully followed.

Contact Poisons—For Sucking Insects

Nicotine Sulphate.—Nicotine sulphate (40 per cent) is the most commonly used contact insecticide for the control of sucking insects on field and garden crops. It is quite safe to use in either spray or dust form on the most delicate plants and can be safely combined with sprays containing insecticides and fungicides. It is usually used at the rate of $\frac{3}{8}$ of a pint to 40 gallons of water, to which has been added 2 pounds of laundry soap to increase its spreading and killing power.



Dust mixer (author's illustration).

Nicotine Dusts.—Nicotine dusts, as used against sucking insects, are gaining in popularity on account of the comparative ease with which they can be applied and their greater effectiveness as compared with liquid applications. Nicotine dusts are made by mixing nicotine sulphate with hydrated lime, the strength of the dust, of course, being dependent upon the amount of the insecticide added. The most generally used dust is composed of 5 pounds of nicotine sulphate mixed with 95 pounds of hydrated lime, giving approximately a 2 per cent nicotine dust. However, when a stronger dust is required the amount of nicotine sulphate may be increased and the hydrated lime decreased proportionately. Nicotine dusts should be used as soon as mixed for best results, but if it is necessary to store them, they should be kept in air-tight containers, since they quickly lose their strength if exposed to the air.

In preparing nicotine dusts, or dusts of other types mentioned later, the process can be speeded up and made much more effective if a barrel mixer is used. This consists of a barrel with an axle run through it, from end to end, which is slightly off centre. This axle has a handle at one end to facilitate turn-

ing and is mounted on a rough frame strong enough to support the barrel when partly filled with hydrated lime. A removable door is fitted in the side of the barrel by means of which the mixer is loaded. Several round stones about the size of a man's fist are placed inside. These have both a pulverizing and mixing effect on the dusts. The hydrated lime and nicotine are added, the door closed and the barrel turned slowly for 5 minutes, by which time a thorough mixing of the contents will have taken place. The dust is then removed and either used immediately or stored in tight containers.

Special Formulae

Bordeaux Mixture.—Bordeaux mixture, although primarily a fungicide, is also used as a control for many species of flea beetles and some leafhoppers. It is practically always used as the basic liquid when spraying for potato beetles, since it is the standard remedy for many important potato diseases. Bordeaux mixture is made by mixing copper sulphate (bluestone), hydrated lime and water together in the following proportions:

Copper sulphate (finely ground)	4 pounds
Hydrated lime	4 pounds
Water	40 gallons

The method is greatly simplified if finely ground copper sulphate (snow) and hydrated lime are used. After the spray tank has been filled with water, the engine is started and the correct amount of finely ground copper sulphate gradually added. With the agitator running, the fine powder will be thoroughly dissolved in 5 minutes. In the meantime the hydrated lime is placed in a large pail and slowly stirred with a stick while sufficient water is added to fill the container. After thorough mixing, the liquid is then gradually added to the now dissolved copper sulphate in the spray tank, while the engine and agitator continue to run. This proceeding is repeated 2 or 3 times until all the hydrated lime, with the exception of the insoluble foreign matter in the bottom of the pail, has been carried over into the spray machine. The Bordeaux mixture, which is pale blue in colour, is now ready to apply. Where small hand sprayers are used the method is exactly the same except that the agitation of the liquid in the sprayer will have to be done by means of a flat stick in the absence of an engine and mechanical agitator.

Bordeaux Dust.—In combating flea beetles or in treating potatoes for insect enemies, a Bordeaux dust may be used in place of the regular poisoned Bordeaux spray. Such dusts can be purchased from all commercial spray companies, ready mixed, or they may be prepared on the premises provided a good mixing machine is available. The following is the standard formula for Bordeaux dust:

Copper sulphate (dehydrated and ground very fine)	12 pounds
Hydrated lime	80 pounds
Calcium arsenate	8 pounds

The amounts of copper sulphate or calcium arsenate or both can be increased to suit the insect, but this must be compensated for by reducing the amount of hydrated lime to a corresponding extent so as to keep the total at 100 pounds.

Poisoned Bran Bait.—This bait is used chiefly for controlling cutworms and is composed of the following materials:

Bran	20 pounds
Paris green	½ pound
Molasses	1 quart
Water (about)	2½ gallons

The dry and wet ingredients should be mixed separately and then brought together in a tub or other large receptacle and the whole thoroughly stirred. When fully mixed the bait should be of the consistency of wet sawdust and should crumble and slip easily between the fingers. Do not have it too wet, since, if sloppy, it is impossible to spread it thinly and evenly over the ground.

THE MORE COMMON DISEASES OF POTATOES

Contributed by the Division of Botany and Plant Pathology, Science Service

A. FOLIAGE DISEASES

In order to appreciate fully the necessity for the prompt control of foliage diseases, the grower should realize that the leaves of plants are far more important organs than is generally thought. They are responsible, in a large measure, for the manufacture and subsequent storage of plant food. Any injury, therefore, interfering with leaf activities will soon affect the health of the plant and eventually the yield. This is especially the case in tuber-bearing plants like the potato; hence, it is of great importance to protect the foliage from injury of any kind, whether mechanical, physical, or due to insects, fungi or virus troubles. The following pages deal briefly with the more important diseases affecting potatoes.

Early Blight

Early blight is caused by a fungus, *Alternaria Solani,* which survives the winter in the soil or on potato stalks. The disease appears on the foliage as dry, dark brown to black, circular or oval spots, irregularly distributed over the leaf surface, and marked by target-like rings or ridges. The last-named feature readily distinguishes this disease from late blight. In the early stages, affected areas are small and angular. Later, the spots enlarge and, if severe, may eventually kill the greater part of the leaf surface. Early blight is also known to attack the tubers. On the tubers, infected areas appear purplish-brown, sunken, circular to oval, varying in diameter from $\frac{1}{4}$ to $\frac{1}{2}$ inch; the lesions are surrounded by a thin raised border.

Late Blight

Late blight is so called because it usually appears later in the season than early blight. It is caused by a fungus, *Phytophthora infestans*, which is spread by rain, wind and machinery. Late blight appears principally on the leaves and occasionally on stems as irregular, water-soaked areas surrounded by a yellow edging or margin. Later the spots turn brown and may cause a rapid decay of the entire foliage. Prolonged periods of warm, moist weather favour the development of the disease. The lower sides of the leaves often show a delicate white mildew, the fruiting stage of the fungus. Rain washes the fungus off the affected tops; it thus reaches the soil and gives rise to the well-known "late blight" tuber rot. This rot appears externally as purplish, and internally as rusty brown areas, which may involve part or the whole of the tuber. Under poor storage conditions the affected portions are usually attacked by other germs which produce a typical dry rot, rendering the tubers useless for table or seed purposes.

The Control of Foliage Diseases

Foliage diseases may be controlled by spraying or dusting with Bordeaux mixture or a copper-lime dust. Bordeaux mixture should be applied at least 5 times for early and 6 to 8 times for late varieties, beginning when the plants are from 6 to 8 inches high. The spray should be applied at intervals of 7 to

10 days. Sprays discharged at a pressure of 200 to 300 pounds are most efficient. Applications should be made before rainfall and preferably at a time of day when the spray will dry on the foliage before evening. The spray mixture generally recommended is composed of 4 pounds of bluestone (copper sulphate), 4 pounds of lime, and 40 gallons of water. Lime may be of the hydrated form and should be of the best grade procurable. Stone lime is preferable, but should be thoroughly slaked. The most economical method is to prepare a stock solution of the bluestone and the lime in suitable containers. Two barrels of 40 gallons capacity are quite convenient. In the first barrel place about 30 gallons of water, and dissolve in it about 80 pounds of bluestone by suspending the chemical in a sack just below the surface of the water. When the chemical is dissolved add water to make up to 40 gallons. In the second barrel place 80 pounds of the best stone lime and slake it by adding water gradually. When the process is complete add sufficient water to make up to 40 gallons. These casks contain 2 pounds of bluestone and lime, respectively, per gallon. Keep the barrels covered to prevent evaporation and to exclude dirt and other substances that would clog the nozzle of the sprayer. To prepare the mixture for spraying, first determine the capacity of the spray tank. Assuming this to be 80 gallons, pour into the tank 72 gallons of water and add 4 gallons of the bluestone solution (8 pounds of bluestone) and also 4 gallons of the well-stirred milk of lime (8 pounds of lime). The lime solution should be thoroughly strained before putting it into the sprayer. The stock solutions of bluestone and lime should not be mixed.

When copper-lime dust is used, a mixture composed of 80 pounds of high-grade hydrated lime and 20 pounds of dehydrated copper sulphate is used. If a suitable mixer is available these ingredients can be mixed at home. Commercial dust preparations should be purchased only from reliable sources. A dusting machine capable of applying the dust mixture in a fine uniform manner is essential. A distinct advantage may be gained by attaching a cloth curtain to the rear of the dusting machine. This curtain should be long enough to trail over and behind the nozzles. The dust mixture should be applied during calm weather, while the dew is on the plants. The operator should wear a mask to prevent inhaling the dust. Dusting has not proved as satisfactory as spraying during seasons of excessive rainfall. Whether the fungicide is applied in the form of a spray or dust, the main object is to ensure a complete coverage of the foliage with the chemicals.

Avoid at any time using infected tubers as sources of seed. Inasmuch as the late blight fungus is capable of living in the soil about 10 to 14 days, the crop should preferably not be lifted for a period of two weeks after the tops have died. Killing the foliage of the potatoes at the end of the growing season prevents tuber infections to some extent. This can be achieved by spraying with a mixture composed of 15 pounds of bluestone in 40 gallons of water. One to two applications are usually adequate. After the potatoes have been dug the tops should be gathered and burned. Piling blighted potato tops close to dug potatoes, or covering the potatoes with them, should be avoided.

Diseases due to wilts, ring rot, blackleg, or virus, while also exhibiting foliage symptoms, cannot be controlled by spraying or dusting; and, since they also occur in the tubers, suggestions for their control will be found under tuber diseases.

B. TUBER DISEASES

A useful chart showing tuber diseases in natural colours has been prepared by the Division of Botany and Plant Pathology and may be obtained free of charge from the Publicity and Extension Division, Department of Agriculture, Ottawa, Ontario.

Tuber diseases are of sufficient economic importance to warrant applying the control measures here recommended. Some diseases result in a complete breakdown of the tubers; others may spoil the appearance of the potatoes and render them unsaleable, or useless for seed purposes.

Rhizoctonia

Rhizoctonia affects both the tubers and the sprouts and bases of the stems. The fungus, *Corticium vagum,* overwinters on the skin of the tuber, where it causes dark-coloured, disfiguring specks, and in the soil. Affected tubers commonly give rise to weakened plants with bunched upper leaves; for the fungus grows from the skin specks and attacks the outer layers of the stems, forming lesions that may be seen when the plants are pulled up. Diseased plants often produce small aerial tubers.

Scab Diseases

Common scab is caused by a bacterium, *Actinomyces scabies,* that exists in most soils. The disease may attack the tubers during any stage of their development. Affected areas eventually darken and form the well-known scab spots, which occur singly or in groups, and in extreme cases may involve most of the surface, giving the tuber a corroded appearance. Powdery scab is somewhat similar in appearance, but is caused by the fungus *Spongospora subterranea.* The control measures given below are suitable for both diseases.

Blackleg

This disease, which is spread mainly by the use of infected tubers, is caused by a bacterium, *Erwinia phytophthora.* Insects may cause some spread in the field. Infection usually originates in the seed-piece and extends upward, blackening the stem for some distance above the ground level. Affected plants are readily recognized by their upward type of growth, comparatively small size, and light green foliage. The upper leaflets are usually rolled inwards. The disease usually girdles the stem at the base, causing it to decay and turn black. If the disease occurs late in the season, affected tubers are certain to result; some of these enter storage and serve as sources of infection the next season. The diseased tubers show a general blackening and rotting, often particularly of the central pith. The decay does not follow the vascular ring. The tubers may become infected either through the stem end or directly through the skin.

Wilt

Wilt may be caused by various species of the fungi *Verticillium* and *Fusarium.* As the name implies, infected plants wilt in the field. At first the leaves become light green; later they turn yellow and become up-rolled. The lower leaves are involved first; later the upper ones wilt, and the entire plant gradually dies. If the lower part of the stem of a plant in the early stages of wilt is cut through at an angle, it will be seen to be brown inside. In the tuber wilt causes a dark brown discoloration of the vascular ring, particularly at the stem end. It does not often cause much rotting, but makes the tubers unfit for seed and unattractive for table use.

Stem-end Rot

Stem-end rot, caused by the fungus *Fusarium Solani* var. *eumartii,* is similar in many ways to wilt, but its damage to the tubers is more serious. In addition to a wilting of the tops, there is often an internal brown flecking far up the stem. In the tubers there is at first a stem-end browning of the vascular ring; but the injury progresses until the whole of the stem end is shrivelled and almost black.

Bacterial Ring Rot

Bacterial ring rot, caused by *Phytomonas sepedonica,* appeared in Canada only a few years ago, but it is already widely distributed. It is one of the most serious diseases of the potato and one for which all growers should keep a sharp lookout. Affected tubers generally show a creamy or light brown discoloration and a softening of the tissue close to the vascular ring at the stem end. Occasionally the ring decay may spread almost the whole length of the tuber. The affected parts are crumbly as though cooked. In wet seasons the decay may be more evenly distributed through the tuber, or it may even tend to spread along the central pith in much the same way that the blackleg tuber rot often spreads; but the marked blackening that accompanies blackleg is absent in ring rot. Some of the tubers are attacked by other organisms after ring rot has penetrated them, and such tubers are often slimy and foul-smelling. The tubers in a single affected hill generally range from apparently sound to completely rotten. The severely rotted tubers are often cracked and, by pressing the skin, it may be possible to tell that they are partly hollow; but the slightly diseased tubers show no external signs of disease, and they may, in fact, appear perfectly healthy even when cut open. The bacteria overwinter in the infected tubers and, to a lesser extent, on bags, bin walls, and other equipment. When diseased tubers are cut for seed they contaminate knives, planters, baskets, etc., and these in turn contaminate many healthy sets. Most of the spread takes place in the cutting and planting operations. Because of the impossibility of recognizing the slightly infected tubers, no crop that shows even a trace of ring rot should be used for seed. If the disease has been found, all bins, bags, planters, diggers, hoes, etc., should be thoroughly disinfected before new seed is handled; otherwise the new seed may become infected before it is ever planted. The tops of the plants show no symptoms until late in the season. Eventually there is a yellowing and then a browning of the edges of leaflets of the affected stems, and the leaflets wilt while the leaf stalks remain rigid. Commonly one or more stems in a hill wilt and the others remain normal. The browning of the leaf edges is quite similar in appearance to that caused by late blight; and, if late blight is present, the plants affected with ring rot are difficult to detect.

The Control of Tuber Diseases

The use of seed potatoes free from any disease is the ideal procedure. Growers are assured of a superior quality only when certified seed potatoes are used; these, however, are not absolutely free from disease, but within standards that may be attained under practical conditions.

It has been established that the russet types of potatoes are markedly resistant to common scab, the semi-russets slightly resistant, and the thin-skinned varieties most susceptible. None of the varieties common in Canada are considered resistant to such diseases as powdery scab, rhizoctonia, blackleg, ring rot, and silver scurf.

The continuous production of potatoes in the same soil creates conditions favourable to the development of most tuber diseases, regardless of whether the seed is free of the diseases or has been rendered so by disinfection or other means. This is due to the fact that the disease germs exist in most soils and become more virulent by continuous growing of potatoes or other susceptible crops. In consequence, for the purpose of disease control, it is very desirable to practise a rational system of crop rotation, as outlined in another part of this publication.

Owing to the fact that an alkaline soil favours the development of scab, large amounts of nitrate of soda, mussel mud, wood ashes, lime, and other substances that produce an alkaline condition should be used with caution on

soils intended for potatoes. Stable manure should be thoroughly decomposed before using it for potatoes, on account of its tendency, in the fresh condition, to favour the development of certain diseases.

During the dormancy of the potato, diseases are capable of remaining more or less in a resting but viable condition of the surface of the tuber, awaiting introduction into the soil, when the potatoes are planted, to renew attack upon the host. The organisms of scab, rhizoctonia and blackleg existing on the surface of the tuber can be destroyed by proper disinfection with chemicals. Seed disinfection can be accomplished with safety at any time when the potatoes are in a dormant state. The benefit derived from seed treatment, however, is in proportion to the natural infestation of the soil. Where the soil is not heavily infested there will be a high degree of control, but where the organisms are abundant, the actual protection afforded cannot be great. Full information concerning seed disinfection is set forth in pamphlet No. 134, New Series, published by the Dominion Department of Agriculture at Ottawa.

Potatoes should be carefully handled during harvesting, storage, and transportation, in order to minimize the loss from cuts and bruises; because even small skin abrasions may serve as sources of entrance for rot-producing organisms which may ultimately destroy the tuber. When cutting sets for seed, all tubers showing any kind of blemish, or rot inside should be thrown out.

C. VIRUS DISEASES

Virus diseases are largely responsible for the so-called "running out" or "deterioration" of potatoes. Reductions in yield, ranging from 15 to 75 per cent or even more, may result from these diseases, which are widespread in the important potato production sections of Canada. The common commercial varieties are susceptible to most of these diseases. The causal agent is present throughout the sap of affected plants. These diseases are spread by contact of healthy and diseased plants, or by insect carriers such as aphides (plant lice) and leafhoppers. In consequence, it is difficult to produce or maintain plants free from virus diseases in fields close to affected stocks. Tubers from affected plants usually produce diseased progeny the following season. The most important diseases in this group are: mosaic, leaf roll, spindle tuber, and yellow dwarf.

Mosaic

Mosaic is distinguished by a mottling effect consisting of more or less conspicuous irregular light green to yellowish areas distributed without symmetry over the leaf blade. The mottling effect is influenced by changes in nutrition and by temperature and humidity, being more marked when cool moist conditions obtain. Affected plants are usually dwarfed and the leaf blade frequently has a wavy or ruffled margin and an uneven crinkled surface. There is generally no rolling of the leaves.

Leaf Roll

Leaf roll is characterized by an upward rolling of the leaves on the midrib, giving them a somewhat tubular form. Affected plants assume a dwarfed, rigid appearance. The leaves and stems are generally brittle and lack the normal green colour. The lower leaves usually become rolled before the upper ones. In advanced stages the upper leaves may show purplish discolorations. There is no mottling. The stolons of affected plants are shorter than those of healthy ones. The rolling of the leaves, described as a symptom of leaf roll, should not be confused with similar effects produced by insects or fungi or by the subjection of the plants to excessive soil moisture or high temperature, where the lower leaves are rolled but not brittle.

Spindle Tuber

Spindle tuber is so called on account of the cylindrical, spindle-shaped tubers produced. The leaf petioles of affected plants form a sharp angle with the stem, giving the plant a dwarfed and staring upright appearance. The foliage is a darker green than that of healthy plants and there is no mottling. The eyes of affected tubers are more numerous than those of healthy ones. In severe cases the eyes may be shallow and bulged. A condition somewhat resembling spindle tuber may result when the potato plant is deprived of nutritional elements, such as occurs in the case of a stoppage of the fertilizer attachment of the potato planter or when potatoes are grown on worn-out soils. This type of trouble can usually be distinguished from spindle tuber by the marked lack of the normal green colouring matter.

Yellow Dwarf

Plants affected by yellow dwarf are severely stunted. The leaves show a pronounced yellowing and commonly they are rolled upward as in leaf roll. The diseased stems tend to be thickened above; when split open they show internal brown spots and streaks, especially near the top and close to the leaf attachments. Most of the tubers are small and distorted, and they may be cracked. When cut lengthwise they commonly show rusty spots, particularly toward the eye end and just inside the vascular ring.

The Control of Virus Diseases

With the exception of spindle tuber, none of the virus diseases described can be successfully detected in the tuber. All affected plants should be rogued (removed) from the field as soon as they manifest such symptoms, and destroyed, preferably by burning. In roguing, all parts of the plants that might grow again, including the old seed piece, should be removed. Diseased plants should be carried from the field in a bag, or other suitable container, to avoid dropping any of the virus-bearing insects on the healthy plants. Frequent and careful inspection of the fields during the growing season is essential. The most effective and economical method of controlling these diseases is to maintain a special plot for seed purposes, which, if given rigid attention by the grower, will render it unnecessary to rogue the main fields to the same extent the following year.

D. CERTIFIED SEED POTATOES

Good seed stock is fundamental to the production of good crops of high quality potatoes, irrespective of whether the crops are intended for seed or for table stock purposes. Apparent soundness of the seed tubers constitutes no guaranty of freedom from diseases for, notwithstanding good appearance, they may carry virus diseases which are not recognizable in the tuber, but which, nevertheless, seriously affect the yield and quality of the crop. Careful field inspection by competent inspectors, at the time these diseases are observable in the growing plant, is most desirable for all potatoes intended to be sold for seed purposes. It is necessary also to ascertain that the crop is not grown adjacent to potatoes affected with diseases that are transmissible during the growing period. Lack of vigour, poor stands, mixtures and other undesirable factors can also be observed and recorded best at this time.

Certification is a means of recording seed stock that is grown from certified seed, and is of good type, from vigorous plants, and, as far as practical under advanced conditions of farming, relatively free from diseases. When potatoes have been inspected in the field and after harvest by the authorized Dominion inspector, and have been found vigorous and well cared for, and to conform to the seed standards of freedom from serious diseases and of purity of variety,

they may be certified. Official tags are issued for such seed stocks exclusively, and no other type of label carries any official recognition of seed potatoes whatever. If the official tag is not on each and every container, the potatoes in them should not be accepted as certified seed.

There is no act or recognition that debars anyone from freely using any potatoes for seed purposes and, as far as the regulations go, there is nothing to prevent seed firms or anyone else from freely selling any kind of potatoes provided they are properly graded and labelled, and are not misrepresented.

Growers should clearly understand that certified seed does not mean seed potatoes that are entirely free from all diseases and blemishes, for such a result is hardly possible under quantity production, but every effort is made to certify potatoes only from fields that are well kept, and that are practically free from diseases, and where plants are vigorous, and true to variety. Commercial potato growers, whose own stock is badly infested with disease or contains mixed varieties, would find it decidedly advantageous to plant certified seed.

The principal object of the Department of Agriculture in providing the service of seed potato certification is to make available to the potato industry a sufficient quantity of disease-free seed annually, and at most reasonable prices, to meet all demands. This is considered the most practical and economical method of dealing with many of the types of diseases that are carried in the tuber. The fact that this method is popular with the industry is evidenced by the demand each year for certified seed. Over 20,000 acres are now inspected for seed purposes annually. In addition to the domestic demand for certified seed, an excellent export trade has developed, and between one and two million bushels of certified seed potatoes have been shipped to foreign countries every year since 1927.

Certified seed potatoes may be procured through any established seed house, and from most of the regular potato dealers, or direct from the growers. A list of certified seed potato growers, for any province, together with full information on the rules and regulations governing the production of Canadian certified seed potatoes is obtainable on request, free, from the Plant Protection Division, Department of Agriculture, Ottawa.

er to the King's Most Excellent Majesty, 1940.